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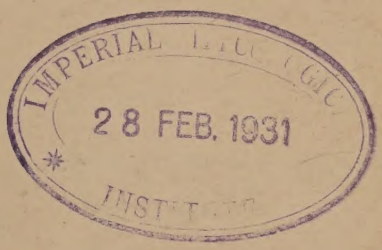

REPORTS RECEIVED FROM EXPERIMENT STATIONS

1929-1930

Price 2s. 6d., post free

LONDON
1931

REPORTS RECEIVED FROM EXPERIMENT STATIONS, 1929-1930

Price 2s. 6d., post free

Published by the Empire Cotton Growing Corporation,
Millbank House, Millbank,
London, S.W. 1.
1931

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PREFACE

By J. C. WILLIS, M.A., Sc.D., F.R.S.

Once again, the most conspicuous thing in the breeding work carried on at the various experiment stations is the success of U.4 and its progeny—for already a number of improved strains, better suited than the original U.4 to the local conditions in the different places, are in process of development. We may be allowed to quote a few of the remarks made about U.4. " U.4 was planted on a large scale for the first time, and gave very good yields, running from 800 to 1,000 lbs, often more, of seed-cotton per acre for ordinary well treated crops " ; " jassid was abundant, but U.4 was practically undamaged " (South Africa, Barberton) ; " the promise which it bears of a more prosperous time for the cotton farmer " (Natal) ; " no variety or strain other than U.4 gave satisfactory results " (S. Rhodesia) ; " U.4 showed that it was considerably better than . . . " (N. Rhodesia) ; " in practically every country in which it has been tried it has fully lived up to its reputation in being a heavy cropper on poor soils, in jassid resistance, and in resistance to drought. In this, its first trial in Uganda, it exhibited all these characteristics, including resistance to Blackarm " " the outstanding feature of the season, from the breeding point of view, was the success of U.4 " (Uganda). And so on.

U.4 is evidently a success, but one must not rest content with that, and already many new strains are being bred from it. At Barberton the attack of jassid was so severe that it facilitated the work of breeding strains that were even more resistant than U.4 itself, and some progress was made in this direction. Two strains U.4/2 and U.4/4 gave an increase in yield, and will be planted on a field scale in the coming season. Cambodia proved to have a definitely greater degree of jassid resistance than U.4, and attempts are being made with crossing, to bring this character into the new strains. On the whole, a number of the new Barberton strains give satisfactory promise, and some of these also show an increase of yield in Natal. In S. Rhodesia " several . . . lead one to hope that despite the ravages of bollworms we can look forward with confidence to the time when cotton will take a much more prominent position in the farming operations of this country " " U.4/64, /26, /130 and others were tried in S. Rhodesia ; none appeared so promising as /64 and to a lesser extent /26. The lint of /64 was quite good, that of /26 rather on the weak side ; /130 is slightly better stapled. The lint of /64 is of good staple and uniformity, but its

ginning percentage is slightly lower. The other good qualities . . . are more than sufficient to compensate " " The lints were more highly valued by the brokers than any previously sent from Rhodesia." In N. Rhodesia U.4/6 proved the best general selection, and was rather late in maturing, a character which looks as if it might be locally useful.

While there is thus a very general consensus of opinion in favour of U.4 and its various substrains, one must not form the idea that the problem of success is now completely solved. In Natal it is noted that " the superiority in resistance of the Cambodia selections over the U.4 strains was rather marked (*cf.* above)." In Uganda " the lint was rather below our present standard, being very harsh, and rather short." In the Sudan, " U.4 did not show up particularly well under " irrigation " conditions, but once more gave indications of being one of the most resistant to leaf curl disease, and . . . was characterised by a . . . high ginning outturn." Some of the disadvantages mentioned may not be of great importance, but attention is called to them to show the nature of the problem that is always before us. Incidentally, the Cambodia strains, though good in jassid resistance, are poorer in other qualities, so that careful crossing must be practised.

The general success of U.4 has tended to diminish the interest taken in other strains, and just as was noted last year, some of them have even been scrapped altogether. Among those, however, that are still being tried—and that the more the further north one goes from the original South African home of U.4—a number are showing up fairly well. We have already mentioned the superiority in jassid resistance of the Cambodia strains, and it is unfortunate that they are deficient in other qualities. In Queensland a new strain of Durango looks as if it might prove somewhat better than the parent stock. In Natal Zululand Hybrid, A.12 and others were still under trial, but none carried anything like the crop of U.4/4. Only further north does U.4 begin to lose its superiority. Even in Uganda, though various descendant strains of S.G.27 and others gave promising results, and also some of those of N.17 and S.G.29—" U.4 proved significantly better than any other strain, followed by S.G.23-8 and N.17."

In Fiji, which has very different conditions of vegetable life, the hybrid of New Guinea Kidney Cotton, previously looked upon as very promising, has had to be discarded, as the cotton proves to be as difficult to sell advantageously as is Sea Island itself. A Kidney-Sea Island backcross is showing promise, and other backcrosses are being experimented with.

While at the moment the question of resistance to jassid is perhaps the most generally urgent question, inasmuch as jassid was the limiting factor preventing successful cotton cultivation in South Africa and elsewhere, there are other limiting factors in other places. Leaf-curl and Blackarm immunity is highly desirable in the Sudan, for example, and bollworm immunity everywhere, and these and other desirabilities must always be kept in view.

At present the breeding of new strains of American cottons, suitable to the new conditions found in the various parts of the Empire, and especially capable of resisting the various handicaps imposed by different pests and diseases, is perhaps the most important line of work in progress. But as one gets races capable of surviving and prospering in any country, one is immediately confronted by the problem of how best to ensure success by methods of cultivation and harvesting.

A great deal of work is being done upon these lines at the different Experiment Stations. The most important and the most general problem that is being tackled is the question of rotation of crops, with which may be considered that of green manuring. Cotton in the United States and in many other countries is suffering from the neglect of these matters in the past. The continual cultivation of the same crop on the same land has often very seriously impoverished the soil (even if it has not sometimes poisoned it), and the result may probably be indicated by the actually diminishing yield to be seen in many places. There is a tendency to grow cotton too often on the same land in Uganda and elsewhere, but the fact that stands out clearly in these reports is that a real interest is now being taken in rotation of crops, and if the Empire cultivators can once be made to take up the subject with enthusiasm, and themselves to practise it, a very great step in advance will have been taken. With sound rotations once established, there is little reason why cotton should not be a permanent crop, giving good yields most of the times that its turn comes in the rotation.

The problem of a suitable rotation is by no means the same even for stations that lie in about the same latitude. Some (*e.g.*, Queensland) have a high proportion of clay in their soil, that wants breaking up ; some have a hard pan close below the surface, which is impervious to many crops, and also requires destruction. In some (*e.g.*, Natal) beetle has to be contended with ; in others bollworm, and so on. Each must work out its own problems for itself in detail, though there are certain general guiding principles common to all.

At present a three-course rotation seems to be the most popular, though one can hardly but feel that perhaps this will be replaced later

on by a four-course. One difficulty in the way is that the ordinary native cultivator must be provided with a potentially profitable crop for every stage in the rotation ; he cannot afford anything in the nature of a fallow, or of a green manure pure and simple, unless under special circumstances (as for example when the Ceylon native *brings* his green manure from uncultivated land). Any leguminous plant put into the rotation must also have some commercial value, and this limits the choice to such things as say, tepary beans, ground nut, or pigeon pea, some of which are proving very useful. In the non-leguminous course of the rotation, tobacco and maize have both been found to be of great use, and there is usually (though not in Fiji) a market available for their produce. As conditions differ so much from place to place, it would be idle to go into detail in this preface, but in general it would appear that a three course rotation, including cotton, legume and a cereal, is in the greatest favour.

Green manuring as such is as yet in less favour. One or two promising green manuring plants have been discovered, and the problem now is to induce the native, by careful demonstration and otherwise, to believe that green manuring is actually profitable in many cases.

In addition to this work, many other pieces of investigation have been going on, with the general object in view of rendering the cultivation of cotton both more efficient and more cheap in regard to labour costs etc., and some of these may be mentioned. For example, as linking on to what has just been said about green manuring, it was found in Queensland that experiment gave a " convincing demonstration of the merits of planting cotton following a long fallow as compared to planting cotton on land where cotton has been grown the previous season with an intervening fallow of only three months." But Queensland is a white man's country, and it may not be easy elsewhere to convince the people of the value of a long fallow.

But before one draws from this experiment any conclusion that fallowing is a generally desirable measure, one should read Heath's account of his experiments in S. Africa (p. 50), where " it was found that a fallow preceding cotton resulted in the latter giving very poor growth in the early part of the season, but better growth later." Here, however, there seems to be a factor in the result that is perhaps different from those in Queensland, for " there are definite indications that an important factor in this connection is the roughness of the winter ploughing after a crop, due to the soil being much drier than after a fallow." Evidently the time has not yet arrived for drawing general conclusions about the effects of fallowing: all the local

conditions and their bearing upon the general problem must first be very carefully taken into account.

An interesting illustration of the suitability of new cultivation for cotton growing was obtained in Queensland, and it was found that new cultivations allow of a much greater range of time of planting, heavy yields being possible from fairly late plantings. This is a result which must be borne in mind in dealing with the crops of new experiment stations.

A good deal of attention was given to determining the best time at which to plant, for as cotton is a new crop in many places, there does not exist any local experience of its behaviour upon which to work. In general early rather than late planting was found to give the best results : " increases the possibility of good yields " " necessity of planting as early as the rains permit " " cotton should be given priority to . . . other crops " " the earliest date is the best " " each successive planting showed a drop in yield," and so on. There is hardly an exception to this general rule, and then it is due to local conditions.

The best distance apart at which to place the plants was also a subject that received much attention. In general it may be said that so far at any rate as yield is concerned, the experiments were mostly in favour of close planting. In some cases the results were not significant, but at Barberton 1 foot apart, in S. Rhodesia 6 inches, and in other places other degrees of proximity, gave the best results. The few results that were given last year were also in favour of close planting, but there are so many factors operating, and they are so different in degree in different countries, that no general hard and fast rule is likely to be discovered or devised, and each country must finally decide for itself, with the guiding indication that in general closer planting is the better. But as yet there has been no remark as to whether this alters the value of the lint, and in view of recent American experience, an authoritative ruling on this question is desirable. In Queensland, again, it was found that the wider spacing gave a more vigorous root growth, and this (which is probably general) must be taken into careful consideration in any country that is liable to droughts during the growing season.

If seed is planted early, it is very liable to be checked by an early drought, and this fact renders the method of hastening germination by soaking the seed, a somewhat risky operation, unless the surface moisture has become linked up to the subsoil moisture, in which case it may prove to be a very useful method (Queensland, p. 15).

Many other features bearing upon improvement in efficiency of cultivation were made the subject of investigation at one or more of

the stations, *e.g.*, hills *v.* drills in Queensland (p. 21), time of thinning in relation to rain Natal (p. 92), ratooning (Southern Rhodesia, p. 125, Fiji, p. 340), fertilisers (Southern Rhodesia, p. 149), and many other things.

Few matters having a direct bearing upon general physiology appear in the reports, perhaps the most interesting (Sudan, p. 239) being that a low soil moisture seems to go with a low ginning outturn.

Turning finally to the very important question of the diseases and pests that attack cotton to a somewhat unusual degree, the first, and most generally important, are the bollworms, and upon these the reports contain many observations as well as experimental results. Very general damage from American bollworm (*Chloridea*) is reported in Swaziland and elsewhere, whilst in S. Rhodesia it was the dominant factor in the situation. There it cleared most of the middle and all the top crop from the better and earlier strains, and all the crop from the poorer and later. As the older and already formed bolls seem to escape to a large extent, this seems to point to early cropping as a remedy, and works in with the results of the experiments on time of planting already mentioned. If one can so far interfere with the " normal " course of nature as to make the cotton earlier, while leaving the bollworm period as at present, one should gain, so long as an " early " mutation does not appear among the bollworms to survive and multiply.

Various parasites of the American bollworm have been bred out, but the experimental work on this method of control is still in its very early stages. Dusting experiments with calcium arsenate show that the older larvae escape, so that early dusting is needful, and the method has the serious practical objection that the arsenate is expensive.

The remedies proposed in S. Rhodesia are planting as early as the rains permit, giving cotton priority over maize, and also closer spacing, whereas in N. Rhodesia, where also the bollworm was troublesome, late planting is regarded as being an advantage, the local climatic conditions, the period of greatest severity of attack, and other factors differing from those further south. One or two substrains of U.4 show somewhat marked resistance to bollworm, and if good resistance can be obtained without losing the jassid resistance or other good qualities that this strain possesses, the breeding of new strains may prove to be one of the best ways of countering bollworm.

Other bollworms, *e.g.*, the Sudan (*Diparopsis*) and the Spiny (*Earias*) were also troublesome in many places. It was noticed that when there is much Sudan, there is less American. Early planting seems of less value as a remedy against Sudan bollworm, and more prolific cottons—perhaps with more but smaller bolls—have been suggested.

The stainer (*Dysdercus*), which is also of great importance as a carrier of the troublesome disease internal boll rot, has likewise received a great deal of attention. Trapping is the preventive measure most generally employed, and while in S. Rhodesia "a fair check was effected," in N. Rhodesia it was considered, after comparatively exhaustive experiments, that "under conditions such as those of the present season, seed trapping . . . is of no value in controlling . . . while hand picking is equally ineffective."

Jassid, which is one of the most formidable enemies to cotton in many regions, and especially in Africa, has perhaps been sufficiently treated above in dealing with breeding, for it is (at present at any rate) by the breeding of jassid-resistant strains that its attack seems to be most easily countered. It is unfortunate that the most resistant type of cotton, the Cambodia, is deficient in other good qualities, but a wonderful start against jassid has been made with U.4, and it may yet be possible to incorporate into this the desirable quality of Cambodia.

Corn-ear worm, aphis, locust, thrips, and many other insects that are injurious to cotton, are also dealt with in one or other of the reports.

Among diseases as distinguished from pests, leaf-curl and Blackarm were as usual the most important. A great deal of work is being done upon them, and we are doubtless coming nearer to the time when their incidence will be greatly reduced. The progress of the work may be followed in the text and in the abstracts of the E.C.G. Review.

Finally, it may be remarked that an increasing amount of progress is being made towards a correlation of the actual facts of the climate at any one place with the incidence of pests and diseases there. We have shown (*cf.* p. i of last year's prefatory note) how the crop is heaviest with a good "average" rainfall, and there is no doubt that part of the heaviness is due to comparatively small loss from diseases or pests. It would seem not improbable, and this is to some extent borne out by the facts recorded in these reports, that a serious "abnormality" of the climate is likely to be followed after a certain time by an attack of some pest. Such abnormalities would include unseasonable droughts liable to make the subsoil too dry, unusually heavy rainfalls, especially when they caused waterlogging, too great sun exposure or too great cloudiness, etc. There are many instances in these reports where some correlation is indicated, and should this prove to be the case on working out a great number of crop returns, it might prove possible to forecast attacks, the local distribution of pests showing which are the most likely. And then preparation could be made for them in advance, and prevention is better than cure.

QUEENSLAND

REPORT ON THE WORK OF THE CALLIDE COTTON RESEARCH STATION, BILOELA, FOR THE YEAR ENDING JUNE 30, 1930.

BY

W. G. WELLS.

SUMMARY.

The climatic conditions during the cotton season at the Research Station have again been unfavourable for obtaining very satisfactory results in many of the experiments which were conducted. The yields obtained, however, were considerably better than those of the preceeding season.

The poor results which were obtained over a large portion of the Station can be explained by the fact that the first planting rains, while sufficiently early, were of a light nature. This enabled only a portion of the cotton plots to be planted, and in most of these the eventual loss of stand during a following dry period was so great as to make them unsuitable for experimental work. Many of the experiments had to be conducted, therefore, in late planted cotton which, as in previous seasons, was so badly attacked by corn-ear worm that the yields obtained were too poor to be of much value. No reference has been made in the report to a considerable number of experiments for this reason. Wherever possible, however, data or observations appearing to be of sound value, were obtained and are presented.

The results of the season which appeared to be of sufficient value to record may be summarized as follows :—

1. Early planting on the older cultivations undoubtedly increases the possibilities of obtaining good yields of cotton on the Research Station and in the surrounding districts.
2. Marked retarded growth of early plantings during the first two months of their development may cause them to react to later excessive rainfall and corn-ear worm attacks in a manner somewhat similar to that of late planted cotton.
3. New cultivations allow of a much greater range of time of planting, heavy yields being possible from fairly late plantings.

4. Ploughing under crops of cowpeas apparently does not increase the moisture-conserving properties of the soils to any marked extent.
5. Such a practice does increase the nitrogen content of the soils and on fertile soils may cause disaster in the following season if excessive rainfall occurs in the critical stages of the development of the cotton plants.
6. Ploughing under saccaline sorghum in the green stage does not increase the nitrogen content of the soil during the succeeding season.
7. Cotton planted on a seed bed which has been prepared during the latter part of the previous period of summer rainfall maintains a better stand and rate of development under dry conditions than when planted on a seed bed which has been prepared later at the end of the preceeding cotton season.
8. Sowing soaked seed expedites the obtaining of a commercial strike by at least 24 hours, even under favourable moisture conditions. It is questionable, however, if this method should be used unless there is ample moisture in the soil to maintain the seedlings for some time without further rainfall.
9. There does not appear to be any advantage gained by spacing the plants singly in hills 3½ feet apart so as to allow cross cultivation, as compared to single plants spaced 2 feet in drills, when the rows are 4½ feet apart.
10. It does not appear advisable to space the plants in bunches of 2 or 3 at distances of 2 feet apart, or not to thin them, even when the stand is rather poor. Such spacings appear to react to dry spells, heat waves, and periods of excessive wet more than do single plants spaced 2 feet apart when 6 to 7 inches tall.
11. The corn-ear worm, under Queensland conditions, is undoubtedly one of the greatest factors bearing on the yield to be obtained from all plantings—other than early plantings which make good development during the spring months.

Seasonal Conditions.

The seasonal conditions during this past season have been the most varied of any yet experienced at the Research Station. Generally, the maximum and minimum temperatures during July were below the average of the previous four seasons, the minimum being particularly so, the night of the 19th, when 18·2°F was registered, being the coldest

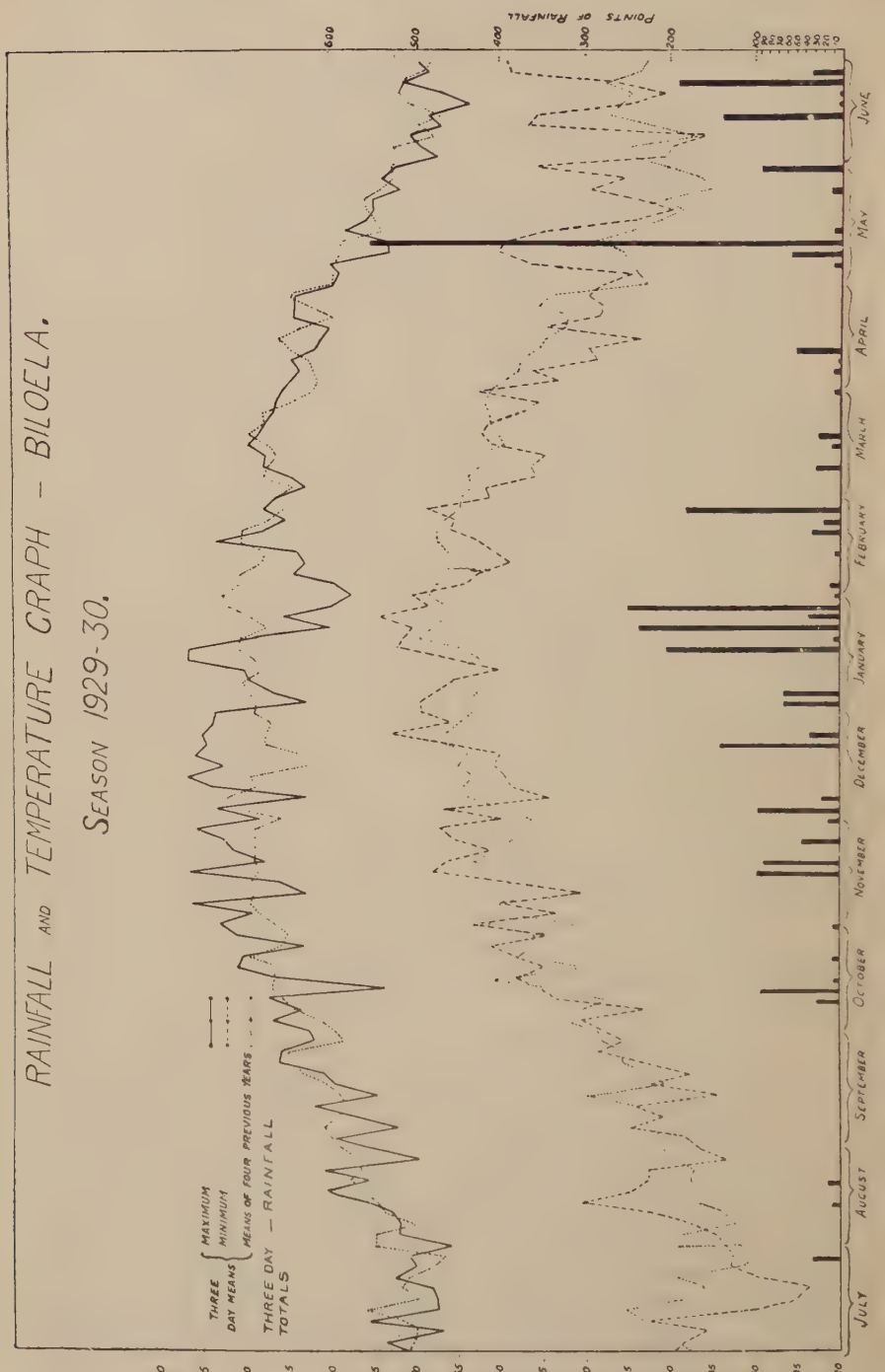
since the Station has been established. The minimum temperatures during August were considerably above the average, as were the maxima towards the end of the month. September was generally cold and rainless, but mounting temperatures in October terminated in 1·21 inches of rain over the period 10th to 13th October. After this hot dry conditions existed until the 13th November, when a ten-day period of showery weather set in, during which 2·42 inches fell on 7 days.

The maximum and minimum temperatures were considerably above the average for the rest of November, but December was marked by unusually low night temperatures until the latter part of the month. The day temperatures on the other hand, were well above the average, with the exception of the first week, when rain occurred. January experienced rather hot nights, but was marked by two very cool depressions in day temperatures, the latter part being exceedingly low. This continued on into February, when a most prolonged period of low day and night temperatures occurred. March likewise experienced very cool nights, but average day temperatures, as did April, and both months were exceptionally dry. May, which is usually a dry month, received 6·13 inches of rain from the 6th to the 10th, which was accompanied by exceedingly high night temperatures for that time of the year. Contrary to expectation, frosts were not experienced following the rains, and exceptionally warm nights persisted through the rest of the month and in June, until the night of the 9th, when a light singeing frost occurred.

Cotton.

The yields over the whole of the Station have again been mostly disappointing, although appreciably better than those of the previous season. The explanation appears to lie in the unfavourable climatic conditions which existed through the proper planting period and at different stages of plant growth, along with the effects of a most severe corn-ear worm attack.

A considerable portion of the cotton plots was planted following the mid-October rains, but the surface soils were so dry that the limited rains did not provide sufficient moisture to enable all the seedlings to develop until they reached the subsoil moistures. This resulted in considerable dying out of the stands, which were further damaged by a severe attack by false wire-worms. The mid-November rains firmly established the remaining stand of the first plantings, however, and allowed of the rest of the plots being planted. The latter plantings, while obtaining a very good stand, soon lacked for moisture during the dry period in December when plant growth slackened appreciably. The light rains at the end of December and early in January relieved


RAINFALL AND TEMPERATURE GRAPH - BILOELA.
SEASON 1929-30.
THREE DAY MEANS { MAXIMUM, MINIMUM, MEANS OF FOUR PREVIOUS YEARS
THREE DAY TOTALS — RAINFALL
TEMPERATURE ON FAHRENHEIT SCALE
POINTS OF RAINFALL
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE

the situation somewhat, but the heat wave, extending from the 12th to the 16th of that month, when the maximum reached 104°, practically stopped plant growth. This checking of growth was extremely unfortunate, for nearly the whole of the plots on the Station had experienced a very severe corn-ear worm attack during the latter part of December and in the first week of January. Any cessation of square formation following the attack, therefore, meant lost possibilities and reduced the control of vegetative growth. The heavy rainfall during the latter part of January quickly stimulated rather rank growth, especially where terminal loss had been heavy through corn-ear worm attack; in some borders as much as 90% of the main terminals were taken. Generally speaking, by the end of January there appeared little chance of anything but a very light crop being obtained over the Station, although a few of the October planted plots had set some bolls and carried an appreciable number of squares.

A most unusual plant reaction developed during the period of cool temperatures in February which followed the spell of wet weather. By the middle of the month the plant growth had clearly steadied down and some plots gave evidence of soon requiring more moisture. A rather heavy rate of squaring was occurring in most plots and flowering was becoming fairly general. This condition was intensified by the hot period towards the end of February.

The explanation of such a quick checking of growth is not clear. The soil moisture determinations showed on the 17th January at the 4″ to 6″ levels 19% moisture—on the 31st this had risen to 24%, but by the 14th February there was but 16% moisture in samples taken from strictly comparable locations. As the temperatures were decidedly cool and much below average during the first fortnight in February, with the evaporation readings rather lower than usual, it would appear that possibly rapid development in leaf surface of such a succulent nature may have increased transpiration to an unusually high degree. As a good mulch had been maintained, it was most surprising to see such a quick loss of soil moisture and checking of plant growth.

By mid-March most of the plots over the Station were carrying a remarkably good top crop of squares and small bolls. All plots were requiring moisture, however, and some on the lighter soils were checking badly. This condition became worse the longer the rains were delayed, and by the end of April it appeared that many of the crops would be total failures. The unusual combination of heavy rainfall early in May followed by a long period of high temperatures, changed the whole aspect of some areas with the result that comparatively fair crops were picked in several plots by the middle of July. It is possible that, had

the first frosts been heavy enough to force the bolls to open, a better yield would have been obtained in some of the plots where heavy top crops developed.

Generally speaking, most of the crops could be described as having started off rather unfavourably, but recovering fairly satisfactorily during the first half of March, owing to the unusual climatic conditions in February. Had rains occurred then undoubtedly good yields would have been produced. As it was, however, it was only the unusual rainfall early in May and the mild temperatures following that period that allowed of the harvesting of what crop was obtained.

Cotton Experiments.

The experimental work in cotton was badly disarranged this season through the faulty stand obtained in the first planted plots. As it was considered desirable to leave the remaining stand in these areas for seed increase purposes, it was necessary to omit some experiments and the rest had to be fitted in with the later plantings. Good stands were present in all of these plots, but the unusual climatic conditions, the attacks from the corn-ear worm, and the heavy loss of terminals over most of the plots on the older cultivations may have affected the results obtained. It is questionable, therefore, if the lack of differences between the treatments, which was shown in several of the experiments, can be considered indicative of the merits of the treatments over a series of seasons.

Every effort was made to make the experiments as reliable as possible, however, the method of comparison in randomized plots, several plots to a treatment, being used wherever possible. With two treatments " Student's " method was used to analyse the results, while with more than two the method of " Analysis of Variance " developed by Fisher, was used.

New Cultivation Effect.—An interesting illustration of the suitability of new cultivation for cotton-growing was obtained this season on two new blocks which were brought under crop for the first time. The timber on these areas had been killed for some seasons, and to some degree had also been " stoved " out, *i.e.*, stumps and roots burned out by slow fires burning for several days. During the winter months prior to the planting season the land was completely cleared of all timber and roots, and first skim ploughed to destroy the heavy covering of grass roots, then later ploughed sufficiently deep to turn under the dead grass roots.

In one block cotton was planted at the same time as on an old cultivation area which was separated by a 20 ft. roadway. This area

has always produced good yields when planted early, but late planting has not given satisfactory results. The yields since it was brought into cultivation from a state similar to that of the new block have been as follows :—

1925/26—good crop maize—adjacent border 1,396 lbs. seed cotton.
1926/27—1,890 lbs. seed cotton.
1927/28—1,677 ,, ,, ,,
1928/29— 190 ,, ,, ,, (6th December planted).
1929/30— 588 ,, ,, ,, (21st November planted).

The seasons in which good yields were obtained were where planting was effected before November. In such seasons a very fine type of plant developed which bore profitable crops of cotton of good quality without much loss being experienced from corn-ear worm attacks. In 1928/29 and this past season the late planted crops were severely attacked by the corn-ear worm early in their development, with the result that a comparatively rank growing plant developed which bore little crop. The foliage of such crops was very dark green, succulent, and gave indication of more than ample supplies of nitrogen being present.

In the adjacent block of new cultivation a plant growth of entirely different nature developed. Planted on the 23rd November good growth was made and thinning was performed twenty-four days later when the plants were 7 to 8 inches tall. Squaring was general by the 28th December, and heavy by mid-January, following the rainfall at the end of the year. Fairly sappy vegetative growth developed, following the excessive wet in January, which was quickly checked during the cool dry period in February. Shedding occurred rather freely in the bottom and early middle crops following this check, but when the plants were 24 inches tall a heavy crop of flowers and squares was being carried. During the dry spell early in March the plants soon appeared to be suffering from a physiological drought effect, although the rains at the end of February had not been sufficient to cause it. The whole block became of an anæmic appearance and considerable shedding occurred, although the plants still retained a good crop. A decided check in development of structure occurred during the dry weather in March and April, the fruiting branches being greatly checked, the internodes being shorter and fewer in number than is usual for normal plants. The stalks were of a deep red colour and the leaves small and light yellowish green—a marked contrast to the appearance of the plants in the neighbouring plot.

Had good rains fallen in March, it is possible that not only would a better fruiting structure have developed, but the plants might have

had a more normal colour. As it was, they behaved like crops growing under extremely droughty conditions on types of soils which analyses have shown to contain only fair to low amounts of nitrogen. A yield at the rate of 1,667 lbs. of seed cotton per acre was obtained, however.

Somewhat similar results were obtained in the other block of new cultivation, although the companion block of old cultivation was not so comparable in soil type and the centres of the two areas were about 200 yards apart. The contrast was all the more marked here for the older cultivation was planted in mid-October, although much of the stand did not come up until the planting rains for the newer block occurred around the 20th November. The yields on the old block averaged 684 lbs. seed cotton per acre, while those on the new block averaged 1,460 lbs. Had rain fallen in March, an even greater difference would have been obtained, for the plants in the new area gave unmistakable evidence of drought effect, which was undoubtedly intensified by the exceedingly heavy numbers of large bolls borne on the bottom and lower middle crops.

This new cultivation effect has been noticed in previous seasons on the rich alluvial soils both in the Callide Valley and in the Upper Burnett. Crops on the newer soils not only seem to have a better "growth control" factor operating, but they also appear to experience less loss from corn-ear worm attacks. As the functioning of this factor appears to be closely correlated with a lack of attractiveness to the moth of this caterpillar, this latter feature is not surprising. It is possible, therefore, that this phenomenon may suggest a method of escaping damage from the corn-ear worm in late planted crops. Obviously, new country cannot continually be brought into cultivation, but if there is a nitrogen starvation factor operating in these newer soils, it is possible that some method can be evolved to approximate to it, if not to reproduce it entirely.

Fallowing Experiment.—The experiment of this season gave a most convincing demonstration of the merits of planting cotton following a long fallow as compared with planting cotton on land where cotton has been grown the previous season with an intervening fallow of only three months.

A crop of Giant Panicum was harvested for hay off the long fallowed portion and the land ploughed on the 5th April, after which a good seed bed was maintained during the winter. The portion previously under cotton was cleared of the old bushes and ploughed on the 1st July. A good seed bed was maintained during the rest of the winter, both plots being harrowed each time any operation was performed.

Both plots were planted on the 15th October and good strikes obtained. Damage by the false wire-worm and dying out of the seedlings soon reduced the stand in the cotton-following-cotton border, whereas the plants in the planting following the long fallow made good steady growth throughout the dry period prior to the rains in November. The stand in the plot of the shorter fallow was so badly affected by then that it was replanted after these rains. A very good strike was obtained on the replant and by mid-January the later planting averaged 5 to 6 inches in height, which was in marked contrast to the plants in the adjacent border of long fallow treatment. A randomized selection of 100 plants in this border showed that the mean height was around 12 inches.

The border which had the longest fallow maintained a marked superiority all the season over the adjacent border of short fallow, and but for having been badly mutilated in one portion adjacent to the lucerne would probably have given one of the best yields on the Station. As it was, a yield at the rate of 969 lbs. of seed cotton per acre was obtained off it as compared with 449 lbs. on the late planted, short fallowed border.

It is unfortunate that the stand in the shorter fallowed border was destroyed so much as to necessitate replanting, since the addition of this factor of late planting does not allow of a comparison being made of the value of the longer fallowing. It was noticed, however, that in any of the plots which had been ploughed about April a better strike was maintained and a better development of the seedlings took place than in adjacent plots of short fallowed plots. In most of these plots, however, some form of green manure had been ploughed under so the increased amount of soil moisture may possibly have been influenced by this factor as well.

The results obtained from the fallowing experiments of previous seasons have not been consistent. In 1924/25 it appeared that a gain of 589 lbs. was obtained ; in 1926/27 and in 1927/28 there did not appear to be much difference ; in 1928/29 the experiment was so badly damaged by corn-ear worm attacks that it was of no value. It would appear from studying the seasonal records during these seasons in conjunction with the yields obtained from the experiments, that the best value is obtained from the long fallows in springs of low rainfall. When good growing conditions follow planting there is a greater factor of safety which carries the plants through any short dry spells. Under very good growing conditions it is possible that the long fallows may even be somewhat detrimental, especially if a wet winter has been experienced, for the plants might be inclined to make rather sappy growth, par-

ticularly on rich soils. They would thus lose the value of the " checking up " effect which is usually occasioned by any spells of dry weather during the early development of the plants on normally prepared seed beds. The general experience of Queensland spring months, however, is that only light rainfall can be expected, so it is recommended that on most soils early preparation of the seed bed is desirable in order that not only may strikes be obtained from the first planting rains, but that they may be maintained during any dry periods following planting.

Green Manuring.—There are considerable areas of soils in the different cotton-growing districts which contain a rather high proportion of clay. In seasons of ample rainfall these soils produce splendid yields of cotton of good quality. During dry spells, however, they are inclined to be somewhat droughty and considerable variation in length of fibre often occurs on the one plant. In past seasons experiments have been conducted on the Station to ascertain the effect, on such soils, of ploughing under crops of cowpeas or Mauritius beans. Generally speaking, the results have appeared to indicate that this practice gives an excess of nitrogen on the clay soils. Some slight increase, during dry periods, in the water-holding capacity of the upper layers of the soils may have been gained, while the soil appeared to be made more permeable to a depth of approximately 10 inches, even in the second season after the cowpeas were turned under.*

During this past season the testing of the effects of cowpea green manure crops was again carried out. Also the effect was tested, of ploughing under saccaline sorghum in the green stage to ascertain if the moisture content could be increased without developing such an excess of nitrogen, as appears to be produced where cowpeas are used. In both experiments better germinations were obtained in the plots with the green manures and the earlier development of the seedlings was much better than in the plots of the cotton-following-cotton treatment.

In order to show how definite the differences were, in four comparable pairs of blocks, fifty plants were selected by random tossing of a light stick in the air and taking the plant nearest to which one end fell. The following table gives the mean height of the 50 plants in each block and the height from the ground at which the first check in the development of the main stalk occurred: the measurements were taken on the 7th December, approximately 48 days after the seedlings commenced appearing above ground.

See Soil Moisture Percentage graph, " Reports received from Experiment Stations," 1928–29, page 6.

TABLE I.

Height of Plants in Cowpea Green Manuring Test (Mean 50 Plants per Block).

Treatment.	Block 2.				Block 3.				Block 4.				Block 5.			
	Mean in inches.	P.E. ±	S.D.	P.E. of S.D. ±	Mean.	P.E. ±	S.D.	P.E. of S.D. ±	Mean.	P.E. ±	S.D.	P.E. of S.D. ±	Mean.	P.E. ±	S.D.	P.E. of S.D. ±
Cowpea green manure	10·46	·47	4·92	·33	9·13	·29	3·09	·21	8·35	·28	2·97	·20	9·89	·27	2·81	·19
Control	5·51	·11	1·16	·08	6·11	·15	1·63	·11	5·59	·14	1·46	·10	5·51	·13	1·41	·09
Difference	4·95	·48	2·86	·33	3·02	·32	1·46	·23	2·76	·31	1·51	·22	4·38	·30	1·40	·21
$\frac{D}{E}$ = ...	10·3	—	8·7	—	9·44	—	6·35	—	8·9	—	6·9	—	14·6	—	6·7	—

Height of Plant (in inches) at which Growth Check Occurred (Mean 50 Plants per Block).

Treatment.	Mean in inches.	P.E. ±	S.D.	P.E. of S.D. ±	Mean.	P.E. ±	S.D.	P.E. of S.D. ±	Mean.	P.E. ±	S.D.	P.E. of S.D. ±	Mean.	P.E. ±	S.D.	P.E. of S.D. ±
Cowpea green manure	5·96	·16	1·52	·11	5·34	·22	1·95	·16	4·83	·17	1·59	·12	5·01	·15	1·53	·11
Control	4·06	·12	·72	·08	4·39	·13	1·04	·09	3·71	·14	1·05	·1	3·73	·14	1·04	·10
Difference	1·90	·20	·80	·14	·95	·26	·91	·18	1·12	·22	·54	·16	1·28	·21	.49	·11
$\frac{D}{E}$ = ...	9·5	—	5·7	—	3·7	—	5·0	—	5·1	—	3·4	—	6·1	—	4·4	—

It will be seen that the plants of the green manured plots are considerably and significantly taller than those of the non-treated plots in all four comparisons. Apparently a very marked check in growth occurred in the plants on the non-treated plots, for the standard deviations of the heights of these plants are decidedly and significantly smaller. This appears to be verified in the mean measurements of the height from the ground to the point of checking of growth on the main stalk. A significant difference in favour of the plants in the green manured plots, existed in all four blocks and here again the standard deviations of the means were always significantly smaller for the non-treated plots.

In order to afford some sort of a check and to see if the advantage gained by the plants in the green manured plots was due to nitrogen stimulation or to the longer fallow which these plots had had, two lots of 50 plants in the long-fallowed portion of the fallowing experiment were selected and measured in a similar manner to those in the green manured plots of this experiment. These were combined in one array and compared with a comparable array of 100 plants from similar soils in the green manured plots. While these areas were not adjacent to each other, it is believed that the soils were fairly comparable, as they were in the same series of plots.

The measurements obtained were as follows :—

Mean Height (in inches) of 100 Plants.

Long-fallowed plots	12·14 ± ·15	S.D. 2·3 ± ·11
Long-fallowed, green-manured plots	8·74 ± ·21	S.D. 3·1 ± ·15
Difference	3·40 ± ·26	·8 ± ·19

Mean Height from Ground (in inches to point of check in growth of main stalk).

Long-fallowed plots	6·08 ± ·07	S.D. 1·29 ± ·05
Long-fallowed, green-manured plots	5·06 ± ·14	S.D. 1·80 ± ·10
Difference	1·02 ± ·16	·51 ± ·11

It would appear from these data that the advantage gained in the early development of the plants in the green manured plots of the cowpea green manuring experiment was probably more a matter of better conservation of moisture in the upper subsoils during the winter months than an effect of nitrogen stimulation.

In common with the rest of the plots on the Station the green manuring experiments suffered badly from corn-ear worm attacks, so the yields may not be truly indicative of the comparative merits of the treatments under more normal conditions. Likewise the late frosts allowed of a greater proportion of the top crop being harvested than might ordinarily be obtained. As it was, the yields, in the saccaline green manuring experiment, although very low, were consistently in favour of the green manured plots.

In the cowpea green manuring experiment the advantage was again in favour of the green manured plot, the yields being at the rate of 335 lbs. of seed cotton per acre for the non-treated as compared with 537 lbs. for the treated plot. As has been the case in past seasons, the plant growth on the cowpea green manured plots was excessive during periods with good rainfall. During dry spells in the latter part of the season some advantage appeared to be gained, probably due to the nitrogen stimulant making greater root systems. In wet periods, however, very dense succulent growth developed.

Soil moisture percentages were taken in this experiment in a manner similar to that described in the 1928-29 report of the Station. During the first half of the season the soil moisture content in the green manured plot was appreciably higher. During the latter half of the season, however, the graphs of the two treatments were practically similar at all levels. This was to be expected as the demand on soil moisture by the plants during the prolonged dry spells would tend to level up any treatment effect.

The determinations have been continued through the winter and spring months. It is interesting to note that the marked difference between the two treatments in the 4 to 6 inch level, which existed last spring, have not been obtained so far this season. The graphs at this level are practically similar, as was the case in the 1928-29 graph at the beginning of the season, which also was the commencement of a second crop of cotton after the cowpeas had been turned under. The moisture content has been very high during the winter, but the latest determinations indicate a marked loss of moisture in the 4 to 6 inch level in both treatments. The green manured plot has the higher content in this level (the difference being $1{\cdot}64 \pm {\cdot}495$ %), although the contents at the 10 to 12 inch level are the same. A comparison by " Student's " method, of the percentages in both levels at every location in each treatment, indicated that the differences were highly significant in each treatment, the odds being about 200 to 1. As the percentages in the upper levels are still 18·5, and better, it is possible that if they continue to drop greater differences may arise between the two treatments.

It appears questionable, however, if any marked advantage from the standpoint of conservation of moisture can be gained by ploughing in cowpeas. Apparently a decided increase in the nitrogen content of the soil occurs, which may be of decided assistance on very poor, droughty, sandy soils. Where cotton is grown in rotation with other crops requiring considerable amounts of nitrogen, it is possible that cowpeas will give the best results as a green manure crop. In such circumstances it is believed that it will be advisable to grow one or two fodder or grain crops before growing cotton.

Regarding the use of the saccaline as a green manure crop, the experiments will have to be continued for some time before anything definite can be obtained. No soil moisture determinations were taken during the season, but the behaviour of the plants during the dry periods indicated some slighter increased resistance to heat waves in the green manured plots. A nitrification test was made in March and the means of eleven systematically collected samples indicated no significant difference between the two treatments, the readings being as follows :—

Nitrogen determinations expressed as parts per million.

Non-treated plots	6·69 ± ·77	P.H. value	7·28 ± ·27
Green manured „	5·66 ± ·44	„ „	7·11 ± ·10

It would appear that the use of the saccaline does not increase the nitrogen content during the first season. It is possible, of course, that through the " nitrogen starvation " factor the nitrogen content may even be materially decreased if the saccaline is well matured when ploughed under. It may be, therefore, that the use of such crops to help in correcting the mechanical condition of the soils for cotton-growing may be more advisable than that of cowpeas or other legumes, unless the soil is of very low nitrogen content. For maize growing the reverse would probably hold true.

Time of Planting Experiment.—Seasonal conditions again prevented the carrying out of the Time of Planting Experiment in which plantings are made in September, October, November, and December to ascertain the comparative merits of each month.

September was dry, but the plots for the October planting were sown following the rains at the middle of that month. Unfortunately the stand was so badly destroyed through seedlings dying from lack of moisture and from attacks of the false wire worm, that it was considered advisable to replant them at a later sowing. It was not until November 19th that this could be done. The next planting was not made until December 21st, so the experiment really consisted of

testing the merits of two late plantings, both made well past the period when former experiments indicate that profitable yields can be expected.

Severe damage was done to portions of all plots of both sowings by the corn-ear worms in their migration from the lucerne, so the results may be complicated by this factor. Generally speaking, however, both sowings developed along lines comparable to those of similar periods of previous seasons. There was a tendency to make excessive vegetative growth during any periods of good rainfall, but the long dry spell during March and April steadied the growth of both plantings to a marked degree. A good crop of squares resulted from this period, and with the abnormally late season better crops were obtained than were expected, those for the November planting being at the rate of 554·5 and 468·5 lbs. of seed cotton per acre, while the December planted ones were 202 and 197 lbs.

An outstanding feature of the planting operations this season was that some of the commercial crops of September and October planted cotton suffered severely from corn-ear worm attack. This is contrary to experiences of previous seasons, but the explanation may lie in the fact that, while planted early, the attacked crops developed much more slowly than usual under the early dry conditions. Prior to the occurrence of the mid-December rains most of the plantings were very backward, so that the rapid growth which took place at the end of that month really was more typical of fairly late planted cotton.

The commercial crops in the district in sections where better rainfall was experienced during the early periods of plant growth, escaped with very little damage from corn-ear worm attacks. Most of them would have made highly profitable yields even without the assistance of the delay in the frosts. As it was very heavy yields were obtained on many of the early plantings. It is believed, therefore, that the results obtained in the Time of Planting Experiments of previous seasons are still satisfactory indicators of the comparative merits of the different monthly plantings as regards yielding ability and susceptibility to corn-ear worm attack.

Wet versus Dry Seed Planting Experiment.—The experiment of this season indicates the danger of planting wet seed following a light rainfall, when the subsoil is dry. A total of 113 points of rain occurred on October 10th and 11th, and it was the 17th before the schedule of planting allowed of this experiment being planted. The wet seed was soaked for three hours in water at 100° F. just prior to planting. The upper surface of the soil was fairly dry at the time, but it was decided to plant to test the value of the wet seed under extreme conditions.

Germination took place on the 25th with a decided advantage in favour of the wet seed, although the stand was fairly patchy. A row in each planting was selected at random and marked off in 2 feet lengths, which is the standard plant spacing. Counts were made daily to determine the degree of approximation to the perfect spacing that was being obtained. The following table gives the results, 322 plants being a perfect spacing of 2 feet apart for the row lengths.

TABLE II.

GERMINATION DATA FOR WET *versus* DRY SEED PLANTING EXPERIMENT.

	October						*November*							
	25	26	28	29	30	31	1	2	4	5	6	7	8	9
Wet seed ...	153	203	206	204	202	214	203	194	185	172	161	180	176	174
Dry seed ...	65	117	122	118	112	122	107	102	100	96	90	99	95	95
Difference ...	88	86	84	86	90	92	96	92	85	76	71	81	81	79

NOTE.—9 points of rain occurred on October 21st, and 6 on the 30th.

It would appear that some advantage was gained by planting soaked seed as regards the germination obtained, but, under the following dry conditions that followed, this advantage disappeared and really represented possibilities lost if good rain had occurred around the middle of November. The dry seed, on the other hand, germinated in such small numbers that it is possible that a good strike would have been obtained had rain fallen in time to save the plants above ground, for at a planting rate of 20 lbs. per acre, there would have been ample ungerminated seed. The soaked seed, on the other hand, would probably start rotting, as the process of germination is started by the soaking, and although a slight increase in population occurred from the light rainfalls four and fourteen days after planting, it is questionable if a good stand would have been obtained in this treatment had rain fallen later. Unfortunately, on account of the stand being so poor, the experiment was eradicated and re-planted when rains occurred on the 25th November, so this point could not be tested.

The assumption that the dry seed would have been all right is borne out by the experience on the Research Station and adjacent farms. In the previous season a very poor first germination occurred in a planting following about an inch of rain. No further rain fell until a month later, when $2\frac{1}{2}$ inches occurred. A heavy germination occurred then which gave a good stand, but, of course, a very irregular growth of

plant resulted, the earlier germinations being 3 feet high when the later were only 12 to 18 inches. This condition would be very unsatisfactory on rich soils owing to the danger of corn-ear worm attacking the late developing plants, but on clay soils it would probably give a much better yield than if the crop had been entirely replanted.

As a further check on the results obtained in the first planting, the plot was re-planted on November 20th following good rains during the middle of the month. Unfortunately, two days after planting, 41 points of rain were received, which tended to level up the effect of the treatment. The counts made were similar to those of the first planting, except that a row was selected at random in each of two plots of each treatment.

TABLE III.

WET *versus* DRY SEED PLANTING EXPERIMENT.

	November						*December*			
	25	26	27	28	29	30	2	3	4	5
Wet	203	281	281	277	288	288	289	282	303	303
Dry	160	206	242	269	282	282	284	284	284	284
Difference	43	75	39	8	6	6	5	−2	19	19
Wet	149	294	294	294	294	294	294	294	294	294
Dry	138	271	271	281	285	285	288	288	289	283
Difference	11	23	23	13	9	9	6	6	5	11

NOTE.—12 points of rain occurred on November 30th, 97 points on the 3rd, and 21 points on December 4th.

It would appear that, even under the favourable conditions, some advantage can be obtained from planting soaked seed where there is ample subsoil moisture. Apparently there was a gain of about two days in obtaining nearly a full commercial strike.

The results of the second experiment are in keeping with those of previous years. Last season under almost perfect planting conditions the soaked seed gave an advantage of about 24 hours. In 1927-28 a 24 hour advantage was also obtained, as was the case in 1926-27.

Unfortunately the climatic conditions in each season have not been such as to allow of a good demonstration of the full merits of the two methods of planting. In previous years good rains falling soon after planting have forced the growth of the seedlings in both treatments

so that a few days' initial advantage have been overcome. In this past season the test under which the first experiment was conducted was too severe. Possibly had it been planted the first day or two after the rains different results would have been obtained. As it was, no significant difference between the yields of the two treatments occurred.

The experiment of this season indicates the limits of the use of the method of planting soaked seed. As has been the case in previous seasons, a gain of at least 24 hours can undoubtedly be effected in obtaining a considerable stand of seedlings by planting soaked seed. This advantage may be lost if the planting rains are light and there is a deficiency of subsoil moisture, especially when rains do not occur for some time after the planting period. Where dry seed is used under such conditions a considerable amount may remain dormant and give a good germination when rains do occur. It is believed, therefore, that planting soaked seed should be done only when there is ample subsoil moisture to maintain a stand of seedlings for some appreciable time. Where such conditions exist it is possible that the quicker germination of the soaked seed may assist in establishing the seedlings to such a degree as to enable them to withstand dry periods during their early development to better advantage than would plantings from dry seed.

Row and Plant Spacing Experiments.—Several experiments of this nature were conducted this season but owing, firstly to poor stands in the early plantings necessitating changing some of the tests to late-planted plots and, secondly, to severe damage being done by the corn-ear worm migration, the experiments have not been satisfactory. The results obtained showed no significant differences and probably are of little value.

Generally speaking, during the first half of the season the unthinned and closer spaced treatments in rows 4½ feet apart reacted more severely to dry conditions than did the treatments where the plants were spaced singly 2 or 3 feet apart. Also, in rank growing areas, the unthinned sections tended to make a tall spindly plant carrying very little fruit. In the latter part of the season the late rains caused the formation of a light crop of bolls per plant, and with the abnormally late frosts a picking was obtained from the unthinned sections considerably in excess of what appeared possible during most of the season.

The following brief descriptions are recorded to allow of some idea being formed of the growth of the plants in the different treatments:

Unthinned.—Small crowded whip-like plants carrying a few bolls which were mostly on the outer fruiting branches of the vegetative

branches. The bolls were generally smaller than those of 2 feet single spaced plants, apparently being checked by lack of moisture. With heavy rainfall in February probably a rank growth of plant would have developed.

Two foot spaced bunches of plants (representing thinning by blocking out bunches containing one to three or four plants per hill).—Plants small and obviously crowded, even where only 2 or 3 were left to a hill, averaged around 3 feet tall and tended to spread away from each other. Bolls borne only on the outer fruiting branches of the vegetative branches. With heavy rainfall in February probably a tall slender growth would have resulted which would have caused the plants to lodge across the rows if a top crop of bolls had developed.

Two foot single spacing.—About 3 feet tall with a good scattering of bolls throughout the plant. Could have developed one to one and a half feet taller without undue crowding. Vegetative branches tended to spread outwards, but sufficiently coarse and rigid to have held up a fair crop.

Three foot single spacing.—Rather coarse growing plants which with wet weather in February might have made excessive development of vegetative branches. A good crop of bolls was borne throughout the plant with many more on the lower fruiting branches of the main stalk than in any of the other treatments. They also were well scattered on the fruiting branches of the vegetative branches.

Terminal loss was very high in all treatments, and the resultant excessive development of vegetative branches nullified spacing effect to a large extent. The observations recorded, however, were made from plants with terminals occurring in the different plots.

In order to study the root development of the plants in the different spacings, randomised selections of 30 plants were made in the single spacings, and 30 hills in the branching treatment. These plants were pulled up when the ground was very wet at the end of the season and the following data obtained :—Diameter of main stalk at cotyledons; diameter of tap root 7 inches below the cotyledons, which would be approximately 4 to 4½ inches below the surface of the ground ; the number of large lateral roots ; and the number of fibrous lateral roots occurring on the main tap root for the first 4 inches below the surface of the ground. Also the large laterals were classed into three groups as follows : (i) ⅛ inch and under, (ii) ⅛ inch to ¼ inch, and (iii) over ¼ inch—the measurement being taken approximately 5 inches from the main stalk. The following table summarises the results :—

Treatment.	Diameter of Stalk at Cotyledons. Mean in $\frac{1}{16}$″	P.E.	S.D.	P.E.	Diameter 7″ below Cotyledons. Mean in $\frac{1}{16}$″	P.E.	S.D.	P.E.
Unthinned	9·47	±·26	2·17	±·19	4·34	±·31	2·49	±·22
2′ bunches	11·31	±·27	3·01	±·19	5·31	±·21	2·36	±·15
2′ singles	14·1	±·26	2·14	±·19	6·57	±·28	2·18	±·20
3′ singles	15·27	±·25	2·03	±·18	6·57	±·23	1·86	±·16
	No. of Large Laterals.				No. of Fibrous Laterals.			
Unthinned	4·4	±·22	1·78	±·15	6·76	±·28	3·17	±·39
2′ bunches	5·21	±·23	2·51	±·16	6·61	±·16	1·81	±·11
2′ singles	7·4	±·26	2·12	±·18	6·7	±·19	1·55	±·13
3′ singles	7·77	±·32	2·59	±·22	6·53	±·25	2·07	±·18
	Class Number for Large Laterals.							
Unthinned	1·4	±·067	·547	±·048	Class 1=diameters of $\frac{1}{8}$″ and under			
2′ bunches	1·64	±·037	·276	±·018	Class 2=diameters $\frac{1}{8}$″ to $\frac{1}{4}$″.			
2′ singles	2·06	±·042	·340	±·03	Class 3=diameters of over $\frac{1}{4}$″			
3′ singles	2·16	±·05	·412	±·036				

It is realised that such data may not be thoroughly indicative of the nature of the rooting system of these treatments, for it does not take into account the sub-lateral rootlets, etc. It is interesting, however, in that there is clear evidence that the 3 feet and 2 feet single spacings had thicker tap roots 7 inches below the cotyledons, and a greater number of laterals than had the unthinned or 2 feet bunched plants. This would indicate a more vigorous general root system and hence, in all probability, a greater network of rootlets. As the plant reactions to heat waves support this theory, it is believed that the data are of some value in explaining the effect of the closer spacings on the root system developments.

It is unfortunate that the tests suffered from corn-ear worm attacks, as the season was a splendid one to test out the theory of close spacing being of more advantage than 2 feet spacing. In countries of fairly regular rainfall during most of the period of boll production it is easily conceivable that, with many varieties of cotton, the closer spacings may give the best results. In Queensland, however, the climatic conditions are very variable even in a season with what might be described as good rainfall. A glance at the rainfall graph for the last five seasons clearly indicates the fluctuations which may take place. The month of February is the critical period in the development of the crop, in many seasons, and any system of plant spacing evolved has to take into consideration the rainfall and temperature variations that occur in that month.

No clear-cut results have been obtained from the spacing tests at the Station over the series of seasons that they have been conducted. The only outstanding season in which 12 inch spacing was better than 24 and 36 inches was in 1927-28, when a most regular rainfall occurred at opportune times. Even in that season the results may not have been truly indicative as a period of heavy rainfall which occurred in the latter part of April not only greatly delayed the opening of the upper crop of bolls, but prevented them from drying out sufficiently to escape being destroyed by what would ordinarily be only a singeing frost. The general results of growers in the district and in the bulk plantings on the Station over a series of years indicate that 2 feet spacing of the plants in rows 4½ feet apart may reasonably be expected to give good results, provided early planting and plant development is obtained. If late planting is done then the corn-ear worm becomes the dominant factor on most soils, and it is questionable if there is much difference to be obtained between the spacings in an ordinary season.

Hill versus Drill Experiment.—The method of planting in hills wide enough apart each way to allow of the passage of cultivating implements is advocated by some growers as a method of reducing expenses of cultivation. Accordingly, experiments have been carried out on the Station for several seasons to ascertain the merits of this method as compared with sowing in drills and then hoeing the plants out to distances of 2 feet apart when 6 to 7 inches tall. A spacing of 4½ feet between rows has been used in each treatment, and 3½ feet between the hills.

An excellent stand was obtained in the experiment of this season which was on a portion of the newer cultivation. This was an unfortunate selection of site, for under the peculiar seasonal conditions the lack of soil moisture for any long period affected the plant growth more than would ordinarily be anticipated in the older cultivations. The planting was made on November 23rd and a good steady growth developed until thinning time. A tendency towards somewhat excessive vegetation started developing from then on and by the end of January a fairly rank growth had been made. The cool weather in February steadied this, however, and a very heavy crop of squares was being carried by both treatments. During March both treatments clearly showed a checking of development and considerable square shedding was noticed. A heavy crop of bolls was forming, however, and a very heavy top crop of squares was setting. Unfortunately the dry conditions in April caused further shedding of squares and checking of plant growth, so that the plants were only of moderate size at the end of the season.

Generally speaking the plants in the hill treatment were of a fairly open habit of growth although somewhat of a coarse type with several vegetative branches per plant. As this vegetative development occurred early in the growth of the plants, the bottom and lower middle crop was rather light. The vegetative limbs carried fruiting branches of good length, however, and these bore a fair crop which was obtained under the conditions of late frost. A good top crop was borne on the main stalk, and generally a considerable proportion of the bolls matured.

The plants in the drill treatment were also inclined to be somewhat vegetative in growth, although they were of a more upright habit and the vegetative branches were not so coarse and large. A considerable amount of shedding occurred through the zones of the lower and middle crops resulting in somewhat light numbers of bolls developing. A very heavy top crop set, however, of which a good proportion matured.

A graph of the flower counts of the means of 12 rows in each treatment, obtained from approximately 330 plants in the hill and 600 plants in the drill treatment, indicates a slight superiority in favour of the drill treatment until the middle of March. From then onwards the larger plants in the hill treatment were consistently slightly ahead, although there was no significant difference in the totals for the period of counting.

A comparison by " Student's " method, of the yields of 12 pairs of plots also failed to show any significant difference between the two treatments. The levelling effect of the season probably accounts for the results. Under the droughty conditions, the plants in both treatments shed a good proportion of their lower crops. The vegetative branches in the wider spacing set a heavy total crop of squares per plant, however, and as the late heavy rains and frosts allowed a good proportion of the top crop of bolls to develop to maturity the vegetative branches tended to offset the smaller number of plants in the wider spacing.

To study the effect on the individual plant, separate boll counts and pickings were made on 90 plants selected at random in each treatment. The data obtained failed to show any difference between the treatments in the following characters: percentage of unopened bolls, percentage of 5 locked bolls, mean weight of 5 locked bolls, mean weight of 4 locked bolls, and mean number of bolls per lb. of seed cotton, although there was a slight tendency in favour of the wider spacing. There was a highly significant difference in the number of counted bolls per plant, in favour of the wider spacing, which had approximately 84 % more bolls.

The results obtained from this experiment in previous seasons have not been very conclusive as far as yields are concerned, owing to disasters at picking time, corn-ear worm attacks, etc. The flower counts in each season, however, have indicated a decided advantage in favour of the 2 feet spacing in both earliness of flowering and in the total number of flowers during the period that covers the production of bolls which could be expected to open under normal seasonal conditions. On the basis of the flower counts for the three seasons in which the experimental results have been worth considering, it appears that in wet seasons, or in seasons when the rainfall is sufficient to cause gradual development of the crop, the 2 feet spacing will give heavier flowering during the first half and will produce a greater total number of flowers for the whole of the period from which mature bolls can ordinarily be expected to be obtained. The later the crop is planted, the greater this advantage may become. In dry seasons, with early or even medium time of planting, it is possible that the wider spacing of plants may be advantageous.

Hill Planting Experiment.—In conjunction with the Hill versus Drill Experiment, an experiment has been conducted in past seasons to ascertain the best number of plants to leave in a hill where the wide spacing is used. This has consisted of sowing in rows 4½ feet apart with hills 3½ feet apart, leaving 1, 2 and 3 plants per hill. Thinning has been performed when the plants were 6 to 7 inches tall.

An excellent stand was obtained in the experiment of this season, which was also on a portion of the new cultivation. The planting was made on November 23rd, and by December 28th squaring was general, being most forward in the one plant per hill treatment. The tendency to develop sappy growth was apparent in all treatments, and following the heavy rainfall in January, the one plant per hill made excessive vegetative development. This was checked by the cool dry weather in February and during March heavy shedding of squares occurred, especially in the three plants to the hill treatment. With the continued dry weather a general restriction of plant growth took place, and at the time of the early May rains, all treatments gave evidence of marked lack of moisture.

Briefly the plants in the one per hill treatment might be described as an open type, although with a fairly heavy degree of development of basal vegetative branches. The fruiting branches were generally of fair length, but showed checks in development corresponding to the dry periods occurring at different times during February, March and April. The crop was fairly well distributed over the plant except the lower portion of the middle crop which was somewhat light.

The effect of competition was apparent in the two plants per hill treatment, the larger plant nearly always carrying most of the crop of the hill. The smaller plant often was of a lanky growth with poorly developed fruiting branches and little crop. The fruiting branches on the larger plant were generally shorter than were those in the one plant per hill treatment. The bolls were fairly well distributed over the larger plants.

In the three plants per hill treatment, competition restricted not only plant size but vegetative branch development as well. Generally there was a decided difference in size in the three plants of a hill. The larger plants produced few vegetative branches, but these occurred low on the main stalk and usually were slender and of an upright habit of growth. The medium sized plants developed vegetative branches somewhat higher up and these were often fruitless. The smaller plants were usually sticklike in growth, with vegetative branches usually absent, or, if present, of twig-like structure carrying no fruit. Broadly speaking, the larger plants carried a good crop, the medium ones a fair crop, while the smaller plants produced mostly only an upper middle and top crop of small bolls.

A graph of the daily flower counts of the means of 12 rows in each treatment from approximately 180 hills in each, indicates very clearly the seasonal effect on flowering habits. Following the heavy rain in January, the one plant per hill produced fewer flowers until the end of the first week in March. Lack of soil moisture was such an important factor after that, however, that the counts for this treatment exceeded the others practically every day. During the earlier stages there was little difference between the counts in the two and three plants per hill, except in the latter half of February, when the two plants per hill were slightly ahead. Towards the end of March the counts in the three plants per hill treatment tended to be better than in the two plants per hill. There was no significant difference in the total number of flowers per treatment for the season, however, although the actual order was 1 plant—first, 2 plants—second, and 3 plants—third.

The results obtained from a 12-block randomised plot experiment gave no significant differences between the three treatments. This is about what could be expected under the climatic and soil conditions, which tended to level differences in plant growth. It is possible, however, that had the rainfall in late February been more satisfactory, the two plants per hill treatment might have yielded the best. It was during the latter half of that month that this treatment was showing considerable superiority over the others in the flower which counts, might have been maintained with better conditions of soil moisture.

The experiment of the previous season was valueless owing to corn-ear worm attacks. In the 1927-28 season, the results obtained clearly indicated the inferiority of the one plant per hill treatment in the earliness of flowering, the total number of flowers for the season, and the yields. No significant difference existed between the 2 and 3 plants per hill treatments in either the flowering or the yields obtained. It would appear, therefore, that if wide spacings between the plants are used it may be of advantage to leave at least two plants per hill or space, rather than one plant. The results obtained so far, however, are not conclusive.

Cotton Breeding.

The operations in developing strains of the Durango variety were further continued this season. The most promising strain bred up from the progeny blocks D.B.13.5 was tested against the main bulk selected stock of the Station and one of the commercial stocks which has been grown for several seasons.

The yields obtained in a 12-block randomised plot experiment pointed to both the improved strains being of equal value and better than the commercial stock. The "z" test suggested by Fisher, however, indicated that the differences should not be considered significant, although they were of considerable magnitude.

An examination of data obtained from 90 random selected plants in each treatment indicated a decidedly significant difference in the number of bolls per plant in favour of the selection as compared with the commercial stock, but not with the bulk selected stock. There was also a tendency for D.B.13.5 to be superior to both the others, in the number of bolls required to make a pound of seed cotton, the weights of 4 and 5 locked bolls, and the number of seeds and motes per lock, although in none of these characters were the differences significant statistically. Classification of the seed types also indicated the existence of a much greater uniformity in the selection.

It would appear, therefore, that the selection has no outstanding advantage in yielding ability over the bulk selected stock, although it may be superior in other respects. The tests will be continued during the coming season on different types of soils for, while the fibre of the selection is significantly shorter than the bulk selected stock, it is equal to the commercial stock, and the impression has always been formed in the selecting operations that it is of better strength than either of the other two stocks.

The usual routine work of testing selections out of the old progenies, and the new selections out of the bulk plots was carried out in the progeny block. The selfing operations were greatly handicapped by

the activities of flower beetles (*Carpophilus* sp.) which were present in large numbers during a greater portion of the selfing period. No outstanding results were obtained, although several progenies appear to be promising as regards strength of fibre.

Insect Problems.

Insect pests have again played an important part in the factors affecting the yields obtained on the Station. As was the case last season the corn-ear worm has been the major offender in this respect, although considerable damage through loss of stand was caused by the false wire-worm. It is also suspected that the false stainer is of more economic importance than has been thought. The pink boll worm, rough boll worm, thrips and the sucking bugs were also present and caused varying amounts of damage.

False Wire-worms (*Gonocephalum* sp.).—This pest was particularly bad this season, not only on the Station but on adjacent farms. The stand of young seedlings in most of the blocks of the October planting was badly affected and several experiments had to be abandoned or transferred to other portions of the Station on later planted plots. One commercial crop of 100 acres within a mile of the Station was nearly completely destroyed, and the whole area had to be re-planted.

The amount of damage caused by the false wire-worm appears to be closely associated with the soil moisture factor and the presence or absence of decaying vegetable matter. This was well demonstrated in the plots in which fallows following green manuring treatments were compared with cotton-following-cotton crops. In seven of the first plots where the land had been fallowed from April onwards very little wire-worm damage was experienced, while in either adjacent or neighbouring plots where cotton was following cotton severe damage occurred which in one plot largely contributed to the necessity of re-planting.

Tests with poison baits* in a crumbly condition strewn along the rows of seedlings indicated that very good control of the false wire-worm could be obtained within a short period. As the usual Paris green-bran-molasses bait, which is also a control against cut worms, was used it appears highly desirable for growers to keep a stock of the ingredients of this bait on hand during the period of early growth of the crop.

*The Manager reported that a bait of 25 lbs. bran, 1lb. Paris green, 1 quart of molasses, and just sufficient water to moisten it was used. This was put on at 8 a.m. one day, and at 5 p.m. the next day a large count of wire worms gave 79 % dead. Seven days later no wire worms could be found in the poisoned area, although in an adjacent plot they were numerous. Another area was baited at 4–6 p.m. one day, and 5 days later in counts of over 200, 90 % were dead.

Cut Worms (*Euxoa Radians* Guen.).—No damage in the cotton plots was caused by cut worms this season. The bulk area of maize, in a portion on rather droughty soil, was severely attacked, however, at the end of November by larvæ in the 4th or more instars. Paris green baits effectively checked the outbreak, which was the only one on the Station. A farmer in the neighbourhood suffered severe loss in his maize crop during the same period. Generally speaking, however, there was little damage caused by cut worm throughout the district.

Thrips (*Thrips tabaci* Lindeman).—The damage caused to the young seedlings by thrips was much lighter this season than it was last year. The reason for this is not clear, for conditions appeared favourable for attacks from this insect which has usually done damage on the Station during the dry spring months.

Corn-ear worm (*Heliothis obsoleta* Fabr.).—The cotton plots over most of the Station have again suffered badly from attacks by the corn-ear worm. In fact, if this pest had not been present it is probable that good yields would have been obtained over most of the experiments on the older cultivated soils. This was the first season that the plantings around mid-October failed to come through with good yields, and while adverse climatic conditions may have played some part in the results obtained, the greatest contributing factor was undoubtedly the attacks from the corn-ear worm.

The lucerne plot adjacent to the block of earlier planted cotton was again the source of an invasion, making the third successive season in which this has occurred. As with previous attacks, a food impulse, presumably through the lucerne becoming unattractive, seemed to be the cause of the migration which unfortunately occurred over the end of a week. When discovered, the adjacent plots were not only nearly defoliated but the terminals of the main stalk, vegetative and fruiting branches of most of the plants were destroyed. Such mutilated plants made a very vegetative growth following the excessive January rains and the results obtained were in no way indicative of the normal merits of most of the plantings.

As was the case in the two previous seasons, the migration was effectively controlled by means of scattering poisoned bran baits along a furrow between the lucerne and the cotton. The bait was also scattered along the edge of the lucerne and as an indicator of the results, in one section as many as 126 dead larvæ per square yard were obtained. As a further precaution baits were spread around the end plants of the cotton plot, as it was noticed that the larvæ rested in the shade of these after crossing the hot bare road. Counts up to 36 dead larvæ per end

bush were made in the evening of the same day, although it is possible that the deaths resulted from poisoned baits eaten in the furrows or close to the lucerne.

This is the third season that the lucerne plot has acted as an attraction for the moths and then later as a source of danger to the cotton crop. This is a feature of all trap crops and one which may make their use of doubtful value. If the lucerne can be cut at the proper time to destroy either the eggs or the young larvæ, it may be that this crop may be useful in assisting in the control of the December brood of the corn-ear worm. A careful watch has been kept of the development of this brood at the Station, however, and the results obtained have been unsatisfactory. If the development of this brood were comparable each season it might be possible to effect some routine control. At the Station, however, the migration has commenced on the following dates:—1927-28, December 26th; 1928-29, December 31st; and this season, January 5th. This is a spread of 10 days over the three years, and it would indicate that the crop of lucerne at this period may have to be cut as a trap crop irrespective of its suitability for being made into good hay. The plot is being left for the coming season for an experiment along these lines, as it is realised that dairying is one of the most profitable enterprises that the farmer can combine with cotton-growing, and lucerne may therefore be grown in many of the cotton areas. The problem of controlling the corn-ear worm may consequently become more important each season as the lucerne-growing expands.

Evidence was obtained this past season which tended to indicate that the corn-ear worm, in the younger stages, may have been largely responsible for the loss of terminals which has occurred throughout the season during the last few crops. This continuous loss of the terminals of the main stalks throughout the season has been perplexing, as no evidence that the damage was being caused by terminal-destroying larvæ such as the rough boll worm and *Eucosma* could be obtained. Several instances were observed this past season, however, where what appeared to be young corn-ear worms were eating the small terminal buds. Experiments have been designed for the coming season to see if this damage can be controlled.

Damage from attacks by the later broods of the corn-ear worm appeared to be much lighter than in previous seasons. The explanation may lie in the fact that a heavy rate of parasitism occurred in the latter stages of the December brood. Two species of the tachinid flies were present in large numbers and busily attacked the corn-ear worm during this period. In March a careful inspection in very suitable cotton

failed to find any eggs, so it would appear that rather effective control had been exercised.

Pink Boll Worm (*Platyedra gossypiella* Saunders.)—The pink boll worm appeared to be remarkably absent from the Station during the past season. Likewise the consignments of cotton received at the ginneries contained many fewer larvæ than has been the case in previous seasons.

Sucking Bugs.—The False Stainer (*Aulacosternum nigrorubrum* Dall.) was present in greater numbers this season than has usually been the case in the past. It has been suspected that this insect has caused considerable loss each season through square and boll puncturing, but it has never been noticed actually attacking either a square or a boll. Fortunately several instances were observed this season in which both the male and female alighted on squares and bolls and inserted the proboscis to a depth of $\frac{1}{16}$ to $\frac{1}{8}$ inch. Inspection of the punctured areas showed definite discoloration. Several of such bolls were tagged for study when matured, but unfortunately only two developed, and both of these had damaged locks adjacent to the point of puncture.

An interesting feature of the activities of these insects was noticed, in that in several instances during the season egg clusters were found on pieces of red rags which had been tied on observational plants as markers. Experiments will be carried out this coming season to see if this factor can be used as a trap early in the evening.

The Large Stainer (*Dysdercus sidæ*).—This pest was not noticed on the Station until February 4th, when a few of the bottom bolls started opening. They increased in numbers from then onwards, but did not reach the proportions of the previous season. This appears to have also been the case in the adjacent districts, for the amount of stained locks in the early consignments received at the ginneries was less than in the previous season.

The *Harlequin Bug* (*Tectacoris lineola*) was again nearly absent.

Flower Beetles (*Carpophilus* sp.).—These beetles, which are of the family *Nitidulidæ*, but are locally called " coon bugs," occurred in large numbers and greatly handicapped the operations in the selfing work in the progeny breeding block. During the early part of the season, before the beetles were present, the selfing could be done by wrapping thin copper wires around the corolla during the afternoon prior to the opening of the petals. After January 6th the beetles occurred in increasing numbers, so that it was necessary to put on small fabric gauze bags to protect the flowers from being eaten into. As the beetles enter into the flower buds by passing between the enfolded petals as much as two days before the corolla opens, it was necessary to put the

bags on at least three days before the buds would open and also to examine the latter to see that no beetles were present.

Owing to the climatic variations and the mal-formed plants resulting from the corn-ear worm attacks, at certain periods during the latter part of the season, the flowering was somewhat light. During these periods the flower beetles, which were in very large numbers, concentrated on the flowers and by the time they opened most of the stamens were destroyed and often much of the staminal column and even the petals were damaged. Unfortunately, no such badly mutilated flowers were tagged for further study to ascertain the effect of such injury, but it is possible that considerable shedding of young bolls may be caused thereby.

SOUTH AFRICA

REPORT OF THE CORPORATION'S WORK AT THE STATIONS AT BARBERTON, TRANSVAAL, MAGUT, NATAL, AND IN SWAZILAND, FOR THE SEASON, 1929-30.

INTRODUCTORY NOTE BY MR. S. MILLIGAN.

The season 1929-30 was an important one so far as the work of the Corporation in the Union was concerned. The excellent crops of U.4 bulk obtained in the previous season by those farmers who were entrusted with its multiplication had provided sufficient seed for the whole of the jassid infected low veld, which forms the principal cotton-growing area in S. Africa. A real *jassid* year was desirable in order to see whether the new variety was sufficiently resistant for large scale planting under the varying conditions met with, and the season was just what was required. Judging from the behaviour of the non-resisting varieties retained at the Barberton Station, partly as an indicator of jassid intensity, it must have been one of the worst yet experienced. These varieties have always yielded some crop, however small; this year they utterly failed to stand up to the attack and produced nothing.

The general crop in the districts was, on the other hand, excellent, confirming the opinion that half a bale of lint per acre and upwards is not difficult to produce in the area in the absence of jassid and with bollworm in moderation, a yield sufficient to enable growers to carry on without loss during periods of low prices and agricultural depression such as are being experienced at present.

The past year thus marks a definite stage in the work of rendering cotton-growing in the low veld a safer proposition. There is now an assured supply of bulk seed of a jassid-resisting variety which has, in addition, proved itself, during the three preceding seasons, capable of standing up to the most trying conditions imaginable, and which with practically no exception has never failed to yield a satisfactory crop.

The character of the season was also of great value to the work at the various stations, especially at Barberton as it put all the re-selections from U.4 through a real test for jassid resistance. Although bulk U.4 appears, from its behaviour outside, to be excellent and quite good enough to go on with, it is undoubtedly quite capable of improvement in many directions through selection, and the value of a searching test of the re-selections at this stage as regards jassid cannot be over-estimated.

Attention has been drawn in previous reports to the importance of the bollworms as a factor in cotton production in the Union. In his report Mr. Parnell stresses the importance of taking into account the behaviour of the various re-selected strains during and after bollworm attacks. U.4 in bulk is well known for its rapidity in recovering after a set back—a very valuable character. But there are very obvious differences within the mixed bulk in the behaviour of individuals after a bollworm attack, more especially with regard to flowering. To retain and fix rapid flowering of the crop at this critical stage is of the first importance.

A special note on insect work has been written for the Report by Mr. Parsons, who, since his transfer from Magut to Barberton has been able to devote some attention to a preliminary survey of the main bollworm problems as they exist in the field. He is able to confirm the utility of ratoon trap crops for early emerging bollworms, especially the Sudan species. A rapid-recovering variety of cotton will, as we have seen, undoubtedly make a difference in early attacks of American bollworm. [Yields of 1,000 lbs of seed cotton per acre and upwards have been obtained on fields practically stripped early in the season.] But no palliative has been found for a late attack of bollworm on a late planted crop, which appears to be especially attractive to the moths. Mainly for this reason the parasite work mentioned by Mr. Parsons is of importance. Difficult though the biolgical problem may be, its solution would result in a diminution rather than an increase of the pest towards the end of the season.

Rotation crops.—These are discussed at length by Mr. Parsons. The question is a most difficult one. No crop tried has come up to cotton as a revenue producer and until something turns up, cotton will continue to be grown too intensively. Soya beans appear at present the most promising alternative crop, provided the results at our stations can be repeated outside. The non-shattering strain Yellow 1 mentioned in the Report will probably help, as the unsatisfactory yields on a field scale hitherto experienced may to some extent be due to loss of grain through shedding. The question of late planting is also important, as alternative crops will generally be planted *after* cotton whether purely from the rotation point of view, or to avoid late plantings of the latter.

Before closing this note the writer has to acknowledge the practical help rendered in many directions by the Department of Agriculture of the Union of South Africa, by the Swaziland Administration, and the courtesy of the Government Officers generally.

REPORT ON THE WORK OF THE COTTON-BREEDING STATION, BARBERTON. SEASON 1929-30.

BY

F. R. PARNELL

WITH THE ASSISTANCE OF

O. V. S. HEATH, L. H. A. STONE AND D. MACDONALD.

Introduction.

The general responsibilities of the officers on the Station have been the same as noted in last season's report. Mr. Stone resigned his appointment at the end of his contract and his place was taken by Mr. MacDonald who was transferred from Swaziland.

The work on rotation crops was taken over and expanded by Mr. Parsons, who has written a separate section on this subject.

It has been impossible to deal adequately with the whole of the results of the season for various reasons. Mr. Heath was away on leave for nearly six months and various members of the staff were away for some time owing to illness. In addition, there is no doubt that too much work has been attempted: more material and records have been collected during the growing period than can be worked up thoroughly during the off season. Proposals are now being made for additions to the staff to fill leave vacancies and to help in relieving the pressure of work generally.

Summary of Principal Results.

General.—The season started early, with heavy rains for over two months, but finished up rather dry. On the Station the excessive early rain resulted in poor growth and crops that were only moderate. In the area generally, where soils are lighter, excellent crops were obtained. U.4 was planted on a large scale for the first time and gave very good yields, running from 800 lbs. to 1,000 lbs., often more, of seed-cotton per acre for ordinary well-treated crops. An excellent average of 690 lbs. *per acre planted*, including wash-outs and bad crops, was recorded for members of the Barberton Cotton Co-operative Co.

Jassid.—This pest was very severe on the Station and entirely destroyed all the old local varieties planted. The violence of the attack

was such that the U.4 strains showed differences in resistance more clearly than in previous seasons. This was extremely useful in making selections for increased resistance, and the season's work should result in a definite step forward in this direction. Many strains were not damaged till they had made a good crop ; the best suffered only some damage to the leaf, at a late stage, with no appreciable damage to their crop. The best strains of Cambodia showed no damage, even to the leaf.

In the area generally jassid was abundant, but U.4. was practically undamaged.

Selections.—It was a good season for sorting out selections, both for jassid-resistance and general yielding characters. Many families showed up well and gave from 1,000 lbs. to 1,400 lbs. of seed cotton per acre. These include a wide range of types of plant that will be carried forward for trial over a number of seasons. About 380 single plants and 25 special bulks will be planted in the coming season.

Variety Trials.—U.4/2, U.4/4 and U.4/4/2, the old selections now in large bulk, were tested against U.4 Bulk in a number of places. The results varied according to the conditions, but all three, on the average, gave an increase over Bulk of over 30 lbs. of lint per acre. U.4/2 and U.4/4 will be planted on a field scale by a number of farmers in the coming season.

Preliminary trials of a number of newer strains showed up several as particularly promising, but the general development of the plant in these trials was very poor and the results apply only to such conditions.

Spacing.—An experiment to compare 1 foot, 2 feet and 3 feet spacing was carried out with two varieties, planted both early and late. In all cases 1 foot spacing was definitely the best and 3 feet the worst. This was the natural result of the very early closing down of the crop in this season.

Time of Planting.—Five different plantings, of two varieties, were put in at about three-weekly intervals from the end of September. The results were somewhat affected by jassid but there is little doubt that the large reductions in yield shown by successive plantings were mainly the result of the different dates of planting.

Fallowing.—As in the previous season it was found that a fallow preceding cotton resulted in the latter giving very poor growth in the early part of the season but better growth later. There are definite indications that an important factor in this connection is the roughness of the winter ploughing after a crop, due to the soil being much drier than after a fallow. This point is being followed up in the coming season.

SEASON.

Judging by the general crops obtained in the district the season was a good one. The total rainfall for the year, July to June inclusive, was 27·59 inches as compared with an average of 28·71 for the previous fourteen years. The type of season, however, was unusual in that the heaviest rains were received very early and later months were comparatively dry. Thus October and November gave over 12 inches, practically equal to the total for the next five months, *vide* rainfall table and chart (pages 58 and 59).

Good early rains during the second week in September gave ample time for ploughing and preparing the land for early planting. Further good rains during October gave excellent planting conditions and the bulk of the crop in the area was planted by the end of this month, decidedly earlier than is generally possible. November and early December were too wet and cold for the young plant and the early growth was poor. Aphis was very prevalent at this time, especially on the heavier soils which remained sodden and cold. It is always found that any conditions unfavourable to growth, *e.g.*, drought, excessive moisture, etc., lead to an increase in the amount of aphis. The growth of weeds was very strong and, as the land was continually too wet for cultivation, it was difficult to keep them down. When they gained the upper hand, particularly in the case of grasses, the crop was quite seriously damaged.

Conditions improved towards the end of December and from that time onwards the season was on the dry side. Growth on the whole was rather small, but flowering and setting were excellent. A feature of the season was the heavy yields obtained from plants of very moderate size.

The crop closed down and ripened off very rapidly, so that by the middle of May there was little left to open. The reason for this is not altogether clear, though the dry latter half of the season, together with the fact that the plants were carrying a heavy crop of bolls for their size, no doubt formed an important factor. Temperatures were down, especially after heavy rain about March 10th, but not more so than in the previous season when the crop finished out particularly well. This rapid ripening-off is apparently responsible for a slight reduction in the length and quality of the lint that was noticed this season. Thus wherever a big crop had opened very quickly the lint was definitely inclined to be short and soft.

The general crop in the area was very good indeed. Practically the whole of it was U.4 and this was planted in the ordinary manner, by planter at a more or less normal seed-rate, for the first time in its history.

The general run of yields from ordinary well-treated crops was about 800 lbs. to 1,000 lbs. of seed-cotton per acre, though in many cases considerable areas averaged well over the latter figure. The Ginnery returns for its members show an area of 5,270 acres of U.4 planted, with seed-cotton received amounting to 690 lbs. per acre. This is a most satisfactory figure since it includes areas washed out, or abandoned for various reasons, in addition to good, bad and indifferent crops.

The ginning percentage, lint baled against seed-cotton received, was very good, amounting to 33·4% for the whole of the main crop, excluding very late pickings. As mentioned above the staple was slightly down, only about one-third of the crop being *Full* $1\frac{1}{8}$ *inches* and half being *Good* $1\frac{1}{8}$, as against the bulk of the previous crop having been *Full* $1\frac{1}{8}$. There was comparatively little staining, 68% being *good colour* and 20% *very light spot.*

On the Station all important planting was done during the second half of October and early November, just about the best time for the area, and excellent stands were obtained. The long spell of wet weather that followed resulted in particularly bad growth, however, as the soil is inclined to be heavy and cold. Aphis was very prevalent, though patchy, and did not go off till about the end of December, when the first good growth was being made. The cotton on the Station was not so good as the general crop in the area and this was noticed in other places with a similar heavy red loam soil. In spite of this, fair yields were obtained generally and some were good. Thus most of the strains in variety trials gave 700 lbs. to 1,000 lbs. per acre of seed-cotton, whilst the best single-plant selections gave 1,000 lbs. to 1,400 lbs. per acre.

Jassid.

Jassid was very prevalent and it was the worst season for this pest that has been experienced on the Station. This is judged from the fact that the old local varieties were completely wiped out and gave no crop whatever. Watt's Long Staple gave no more than a few inches of dried sticks, even worse than Acala in the early seasons, and Barberton Bancroft, Rustenburg Bancroft and Griffin, gave very little more growth and no crop. The plots of these four varieties occupied about one-third of an acre, and, between them, they produced only two or three poorly developed bolls.

Jassid started to breed early in January and continued to increase till well into March. There is little doubt that it was encouraged by the heavy rains early in the season and the poor growth of the young plant. It was specially noticeable on patches where aphis had been bad.

This very severe attack of jassid was the best thing that could have happened from the point of view of the selections, since it gave an opportunity of judging their resistance more certainly than had been possible in previous years. Considering the severity of the attack the strains stood up to it well. Even those that were most severely damaged still managed to produce a useful crop and the most resistant were not affected appreciably, so far as their crop was concerned, though showing some damage to the leaf.

In the area generally there was much less jassid than on the Station, but the U.4 was well tested. Only very occasionally was it appreciably affected and in no case was it prevented by jassid from giving a good yield. The worst cases seen were due to jassid having bred up in a ratoon or very early crop and from there having invaded a neighbouring later crop. Further reference to this style of happening will be made in connection with time-of-planting experiments.

SELECTIONS.

A total of 388 single-plant selections were planted, covering an area of about 15 acres. They were all put in during the last week of October and gave very good stands but, as with everything else, the early growth was poor. One small part of the area had been fallowed in the previous year and here the early growth was definitely bad and the lots concerned were rather spoilt for purposes of comparison. This effect is referred to in detail elsewhere.

The selections were all from U.4 with the exception of 26 from various strains of Cambodia. The latter all showed up well for resistance to jassid, the best of them being practically untouched. As regards other characters there was a good deal of difference between families, though the lots inside one family were generally fairly uniform. Several groups could be discarded at once for bad shedding, others for susceptibility to damage by wind in the field. Further selections were taken from three lots and special bulks from the two best. The latter are quite promising types and will be put into one of the variety trials in the coming season.

The U.4 selections showed very large differences between the families in general habit, earliness, etc., in addition to considerable variation in jassid-resistance. The single-plant lots generally were very uniform and in many cases the lots from one family were fairly uniform amongst themselves. Often, however, there was appreciable variation between the different lots of a family, though not enough to mask the bigger differences between families. As in the previous season a number of types gave good results and the best yielders

covered a wide range. The yields generally were lower, the best ten lots averaging about 1,240 lbs. per acre, as against 1,500 lbs. for the previous year.

The highest yielding lot was from a family, C.28, which is a rather coarse late type, inclined to be woody but fruiting well enough to give a good crop; this gave 1,440 lbs. per acre. Other good lots varied, as regards general strength of the plant and earliness, from about equal to the above down to really small, very early types. The latter gave yields rather lower than the best of the stronger types, the four earliest strains carried forward averaging 1,040 lbs. per acre. These are most attractive types, however, carrying a very heavy crop for their size and putting it on very rapidly. They may be just too small for general use in the area and it is possible that they would be of more use in rather different conditions elsewhere. It is interesting to note in this connection that one of them, U.4/4/2, is reported to have given promising results in Tanganyika.

As stated in last year's report, the policy adopted with the different types must be to compare them over a number of seasons in as wide a range of conditions as possible. It would not be in accordance with this policy to discard all but the very highest yielders on the Station each season, but rather to continue with a number of diverse types that are all doing well.

A point of importance in this connection is the behaviour of a strain in response to any special condition arising. Thus it is fairly common in the area for American bollworm to take the whole of the early crop. When this happens some strains, particularly coarse types, will immediately produce a large woody growth, whereas others will respond with a heavy flush of flowers. Similarly, topping will spoil some types by encouraging vegetative growth, whereas others are less affected in this manner. In the coming season several different types will be definitely tested as regards their response to topping and the removal of their crop at various stages.

Jassid-Resistance.—As already stated, the attack of jassid on the Station was very severe indeed. In the previous season, though there were considerable amounts of jassid, the better strains were resistant enough to show comparatively little damage and it was difficult to distinguish between different degrees of resistance. With the much more severe attack this season, differences showed up very clearly, and it was possible to make selections that should be a definite step forward in the direction of increased resistance.

The variation in resistance was very considerable, especially between the different families. The single-plant lots inside one family were

less variable, though there were generally big enough differences for selection to improve even the best families.

One field showed particularly heavy damage owing to its position between ratoon cotton, used as a bollworm trap, on one side and some very early cotton, in a time-of-planting experiment, on the other. This field was obviously bombarded from both sides, especially from the ratoons, by jassid bred up very early in the season. In future any ratoons will be taken out much earlier, before they can pass on jassid to neighbouring fields. This action of ratoons, however, might be used intentionally for a severe testing of the resistance of strains in special cases.

Some of the families definitely showed too great a susceptibility, their crop being very appreciably affected, and these were discarded *en bloc*. Other strains, particularly early types of a non-vegetative habit, fruited well and ripened a good crop in spite of losing their leaf rather badly with jassid at a late stage. Some of these lots were carried on, since the main object is a good yield and not a plant that looks pretty at harvest time, though their crop would probably have been better, both in quality as well as quantity, if the leaf had remained good to the end. The new selections made from such lots should result in a definite improvement in this direction, but a plant that puts on a heavy crop in a short time cannot be expected to hold its leaf in the ripening period so well as a slower cropper.

A good example of this type was 894, a selection from U.4/4/2, of which a small bulk was grown on about two-thirds of an acre. This lot flowered very heavily, averaging 1·7 flowers per plant per day over a period of 45 days, and set a heavy crop of bolls for a comparatively small plant. It ripened off very quickly and during this stage the leaf was badly damaged by jassid. In spite of this it gave a yield of 1,080 lbs. per acre of seed-cotton of quite good quality.

The strains that showed the least damage by jassid were found, speaking generally, amongst the coarser and later types. With some of these the leaf was not affected till very late in the season and the crop appeared to be quite undamaged. These tougher types were not really heavy fruiting for their size, but the best of them gave the highest yields obtained.

It is difficult to estimate what degree of resistance is really required for the area generally. It is desirable to be on the safe side, so that in particularly bad conditions jassid may not spoil the crop, but it would be unwise to sacrifice other good characters in an attempt to obtain very high resistance if this were not actually necessary. It is felt that the best strains, as they stand now, are resistant enough for all

practical purposes, *i.e.*, that ordinarily their crop would not be damaged at all and that even in very exceptional cases the damage would be only moderate. It remains to be seen whether this view is correct.

There is still room for improvement inside the U.4 strains, but they will not come up to the standard of resistance of Cambodia. As a safeguard, in case a definitely higher degree of resistance should prove necessary, an attempt will be made to bring this into U.4 by crossing with Cambodia. This question was discussed with Dr. Harland, on his recent visit to the Station, and he has very kindly undertaken to make the necessary crosses. A good strain of U.4 will be crossed by the best Cambodia selection and the F.1 back-crossed by U.4 in bulk. A field, several acres, of this cross will be grown for a number of seasons, being carried on by bulk selection each year, before making single-plant selections.

As regards other characters, ginning percentage, lint length and strength, etc., the selections were thoroughly satisfactory. The lint was not quite as good as in the previous season, either in length or strength, but this applied to the crop in the area generally. On the whole boll-weights and seed-weights were slightly lower, ginning percentages definitely higher this season. Figures are given below in Table I, for some of the measurable characters of a number of good lots.

TABLE I.

U.4 SELECTIONS.

Some Good Families.

Family.	*No.*	*Yield per plant*. Special Bulks (grms.).*	*Number of selected plants.*	*Averages for Selected Plants.*				*Remarks.*
				Ginning per-centage.	*Boll weight (grms.).*	*Weight of 100 seeds (grms.).*	*Lint length (mms.).*	
4/1/5 ...	928	116	7	37·4	4·9	9·2	31·1	Early
C.15 ...	9,232	115	7	36·8	5·0	9·5	30·3	,,
4/4/1 ...	921	127	8	37·2	4·9	8·6	31·5	Medium
A.6 ...	9,292	128	8	37·0	4·7	9·8	30·8	,,
Z.6 ...	9,331	123	6	37·7	4·7	9·6	29·8	,,
Z.9 ...	9,313	122	9	38·0	5·0	9·5	30·2	,,
Z.14 ...	9,355	130	8	38·8	4·5	8·6	31·4	,,
4/2 ...	920	127	8	36·8	4·9	9·4	31·2	Late
C.28 ...	9,241	149	5	37·7	5·2	9·6	30·4	,,
C.28 ...	9,243	147	6	39·2	4·6	8·5	30·3	,,
H.77 ...	9,274	127	5	38·2	4·7	9·0	31·4	,,
H.77 ...	9,275	129	7	36·6	5·7	10·4	32·0	,,

* At the normal spacing of 3′ 6″ × 2′.

The above lots, as they stood, covered just over half an acre, and yielded 1,146 lbs. per acre.

For the coming season about 380 single plants have been selected, from 68 lots, and 25 special bulks have been taken. These bulks will be used both for multiplication and variety trials. In many cases they represent a very definite improvement on the original bulk from the same family and it would be useless to carry on the latter for either purpose.

VARIETY TRIALS.

As a result of the previous season's work the older selections from U.4, then in the form of large bulks, had been reduced to three. In addition to these there were twenty small lots, special bulks from single-plant lots, of the newer selections.

Large Bulks.—The three old strains, U.4/2, U.4/4 and U.4/4/2, were put into variety trials with ordinary U.4 Bulk under various conditions, viz., two on the Station red loam, one early-planted and one later, and one on a light granite soil on a neighbouring farm. In addition to these trials at Barberton, the same strains were tested at Magut and in Swaziland.

The two trials on the Station were on the half-strip method with U.4/4 as standard, since there was reason to expect this strain to be the best. The plots were 4 rows by 80 feet, repeated nine times, to give eighteen comparisons of two-row plots. In the early-planted experiment some of the plots were damaged by white ants and had to be cut out, but the worst case gave thirteen comparisons of plots with a good stand. In the later experiment the stand was good throughout and the full number of comparisons was obtained. Here, however, the crop was poor, as the plants did not come on really well at any time. This block was between fields planted a month earlier on three sides and there is no doubt that it suffered from jassid bred up in this early cotton. It should not be assumed, therefore, that the low yields are entirely due to the late planting. The results from these two trials are given in Table II.

In all the following tables of variety trial results the yields are given as *lint* per acre. The differences between strains in ginning percentage is sufficient to affect their value considerably. The percentages, from which the lint figures are calculated, are normally the mean of samples taken from the two main pickings. The strains under consideration gave the following percentages :—U.4/2, 35·5 ; U.4/4, 37·8 ; U.4/4/2, 37·9 ; U.4 Bulk, 36·0.

TABLE II.

OLD STRAINS VARIETY TRIALS.

HALF-STRIP METHOD; STATION RED LOAM.

Date of Planting.	*Strain.*	*No. of comparisons.*	*Mean yield per acre, lint, lbs.*		*Difference from U.4/4.*	*Standard error of Difference.*	*P.*
			Strain.	*U.4/4 Standard.*			
I							
October 16th ...	U.4/2	16	384	358	+26	5·8	<·01
	U.4/4/2	15	339	360	−21	10·5	·064
	U.4 Bulk	13	352	355	− 3	8·8	—
II							
November 14th ...	U.4/2	18	187	187	0	—	—
	U.4/4/2	18	185	190	− 5	—	—
	U.4 Bulk	18	174	192	−18	5·46	<·01

It will be seen that 4/2 has given a rather small though very significant increase over 4/4 in I, whereas they are equal in II. 4/4/2 shows a small decrease in I, barely significant owing to the standard error being rather high, and a negligible difference in II. Bulk shows a negligible difference in I and a small, though highly significant, decrease on 4/4 in II.

The test on granite soil was carried out on the farm of Mr. E. T. E. Andrews, who very kindly provided land for the purpose. Here the plots were of the same size, 4 rows by 80 feet, but they were randomized in blocks, eight times repeated, on Fisher's method. Planting was rather late, but the strains did well and gave very satisfactory yields. The stand was a little poor in places, hence the Standard Error is rather high. The results are given in Table III.

TABLE III.

OLD STRAINS VARIETY TRIAL.

EIGHT RANDOMIZED BLOCKS; GRANITE SOIL.

	U.4/2.	*U.4/4.*	*U.4/4/2.*	*U.4 Bulk.*
Mean yield, lint per acre, lbs. ...	495	533	493	487

Standard error of difference between two strains ... ... 16·0
Difference required for significance (P = ·05) ... ... 33·2

It will be seen that there is no appreciable difference between 4/2, 4/4/2 and Bulk, but that 4/4 shows a definite and significant increase on these three.

The trials at Ingwavuma and Magut are dealt with in the Reports from those Stations. The figures are repeated here, Table IV, along with those of the above Tables, in order to facilitate comparisons of the behaviour of the strains in all the trials. Where the half-strip method was employed the figure given for U.4/4 represents the mean for the whole experiment, the figures for the other strains being adjusted to correspond with this. For the Magut results the figure for lint was worked out on the ginning percentages obtained at Barberton, since samples from the actual trial had not been ginned.

TABLE IV.

OLD STRAINS VARIETY TRIALS.

RESULTS CONSOLIDATED.

Trial.	*No. of Comparisons.*	*Yields of lint, lbs. per acre.*			
		U.4/2.	*U.4/4.*	*U.4/4/2.*	*U.4 Bulk.*
Barberton Red Loam, I...	13—16	384	358	336	355
Barberton Granite ...	8	495	533	493	487
Ingwavuma	12	550	597	594	479
Magut	12	417	434	434	387
Average	...	407	422	408	376
Increase over Bulk ...	...	31	46	32	—

The results on the whole are fairly satisfactory, all three re-selections showing an appreciable increase over Bulk. In only one case, that of 4/4/2 in I, does Bulk show an increase over any of them. In this trial, where conditions were not too good, both 4/4 and 4/4/2 are disappointing whereas 4/2, a definitely stronger type of plant, shows up well. At Ingwavuma, where conditions were good and excellent yields obtained, both 4/4 and 4/4/2 show up well as compared with 4/2 and give a very big increase over Bulk. This is the style of result that may be expected with different types of plant, *vide* last year's Report (page 39).

The best average yield was given by 4/4, an early heavy-fruiting type of moderate size. It is not too uniform, and further selections have been made from it which should give a very good type. It requires to be rather more resistant to jassid and the re-selections should give this. The sub-strain, 4/4/2, is particularly small and heavy fruiting. In all but the best conditions it is definitely poorer than 4/4, being too small to give a big weight of crop. It will not be continued, therefore, in bulk as it stands, but there is a good re-selection, definitely stronger and still very heavy-fruiting, that will replace it.

The behaviour of 4/2 is quite the reverse ; it is stronger, later and generally fruiting less heavily, and is inclined to run to wood in good

conditions or where bollworm has taken the early crop. It is better in rather poor conditions, however, and may prove a safer strain than 4/4. Several re-selections, giving better fruiting, are under trial and are expected to be an improvement.

It was decided not to push either of the above strains, 4/2 and 4/4, for general distribution in the coming season. Both had been grown on multiplication plots on several farms and a few tons of seed of each were available. The farmers who grew them were well satisfied with the results and will put in large areas. The rest of the seed is being distributed to a number of growers for trial on a field scale, the two strains and Bulk being planted side by side.

Small Bulks.—Of the newer selections, in the form of small bulks, the best sixteen were picked out for preliminary trial in addition to multiplication. They were divided into two lots of eight, for two variety trials, and 4/4 and 4/4/2 were also included in each trial.

In both cases the general behaviour of the crop was disappointing. Good early stands were obtained but the subsequent growth was poor and somewhat uneven. Flowering was generally good for the size of the plant, but it went off early and the crop did not finish out well. No adequate reason can be given for this, though the dryness of the latter part of the season was probably partly responsible. Whatever the reason, it may be taken that the conditions were poor and the season short, so that the results given by the different strains have to be recorded as applying particularly to such conditions. The yields for the two trials, together with ginning percentages and lint lengths, are given in Table V.

TABLE V.

NEW STRAINS VARIETY TRIALS.

Trial.	*Strain.*	*Lint yield, lbs. per acre.*	*Difference from mean.*	*Ginning per-centage.*	*Lint Length mms.*
III.					
Planted October 31st.	Z.9	292	+28	37·1	29·3
	U.4/4	285	+21	37·1	30·4
Eight Repetitions.	C.15	277	+13	37·4	30·1
	H.77	273	+ 9	34·8	31·4
	L.17	267	+ 3	36·8	30·3
	H.7	259	− 5	37·7	29·8
	U.4/4/2	258	− 6	38·3	30·5
	H.76	255	− 9	36·8	28·9
	C.39	240	−24	36·0	29·7
	L.18	230	−34	35·9	31·6

Mean = 264.

Standard error of difference between two strains ... ... 14·3

Difference required for significance (P = ·05) ... ... 28·0

TABLE V—*continued.*

Trial.	*Strain.*	*Lint yield, lbs. per acre.*	*Difference from mean.*	*Ginning per-centage.*	*Lint Length mms.*
IV.					
Planted November 5th.	Z.14	295	+43	37·8	30·2
	U.4/4/10	273	+21	39·5	30·6
Six Repetitions.	Z.12	260	+ 8	36·5	29·3
	H.67	257	+ 5	36·6	29·9
	A.19	253	+ 1	37·1	30·8
	U.4/4	249	− 3	38·5	30·3
	Z.13	244	− 8	38·5	29·3
	H.41	239	−13	36·8	30·3
	H.11	237	−15	38·3	30·0
	U.4/4/2	215	−37	38·5	30·6

Mean = 252.

Standard error of difference between two strains ... ... 19·8

Difference required for significance (P = ·05) ... ... 38·8

It will be seen that the yields are all rather poor, the two blocks together giving only 258 lbs. of lint per acre. This is quite as much as could be expected from the poor growth of the plant already mentioned. In both trials there is a wide gap separating the best from the worst, though many of the strains are grouped near the average. The results are looked upon as a rough indication of the behaviour of the types rather than an accurate measure of their value.

The yields of 4/4 and 4/4/2 in the two trials would indicate that the group of strains in IV should be better than those in III. Actually the former were a second choice and were not expected to be so good. Whether this is due to different behaviour in different seasons remains to be seen from future results. It is mentioned here to emphasize the danger of discarding all but the very best lots in any one season.

All the above strains were also grown on multiplication plots of from 1 to $2\frac{1}{2}$ acres. The seed produced is being used for planting field-scale observation plots in a large number of places in the coming season. In practically all the strains the re-selections gave a distinct improvement on these bulks and it was considered, therefore, that the further multiplication of the original bulks would be a waste of time. For the same reason the variety trials in the coming season will be planted with special bulk seed taken from the re-selections. Samples of lint sent for spinning tests have also been taken from the re-selections, since the lint of single-plant lots inside one strain sometimes showed appreciable variation.

SPACING.

Experiments were carried out to test the effect of various spacings on two different varieties and with both early and late planting.

The strains used were 4/4, representing a comparatively small early type, and H.77, as a coarser later type. Three spacings in the row, 1 foot, 2 feet and 3 feet, were used, the inter-row spacing being $3\frac{1}{2}$ feet in all cases. The planting dates were October 17th and December 4th respectively, a separate experiment being put in on each date.

The spacings were randomized in blocks, with six repetitions, and for each spacing half the plot was planted with 4/4 and half with H.77. These half-plots were of six rows each, three for records, two for guard rows against the next spacing, and one as a guard row against the other strain. The rows were 78 feet in length.

The growth was rather disappointing in both plantings and the crop was not very good. The blocks were in a position to catch the wind rather badly and the occasional heavy winds experienced obviously did some damage. The early closing down of the crop was somewhat accentuated by jassid which was rather more prevalent here than on the Station generally.

Weekly measurements of growth of the main axis were made throughout the season on the early planted experiment. Both strains behaved in exactly the same manner as regards different spacings, but H.77 showed slightly more growth than 4/4. The growth curves for 4/4 are given in Fig. 1. It will be seen that the differences between the spacings, though very small, are definite. The increments at 1 foot and 2 feet spacing were almost identical till half way through the main growing season, after which the 2 feet went ahead very slightly and maintained a very gradually increasing lead to the end. The 3 feet spacing started to go ahead earlier, about one-third of the way through, but never gained much on the 2 feet and finished about equal with it.

Daily flower counts were made, on two lines for each plot, in four of the blocks. Here again the behaviour of the two strains was the same and the curves for 4/4 only are given in Fig. 1. As would be expected, the wider spacings gave fewer flowers in the early part of the season. From the end of January they began to even up and by February 22nd the 2 feet spacing had caught up the 1 foot. From this point it went ahead, but the lead was short lived since the whole flowering fell off very suddenly from March 8th. The 3 feet spacing did no more than catch up the 1 foot by this time. It is obvious that, for this season, the closer spacing was a decided advantage. It is very unusual, however, for flowering to stop so suddenly in early March, and further reference to this will be made later.

The figures for yield are given in Table VI, where it will be seen that, in every case, the 1 foot spacing gave the highest, and the 3 feet spacing the lowest yield.

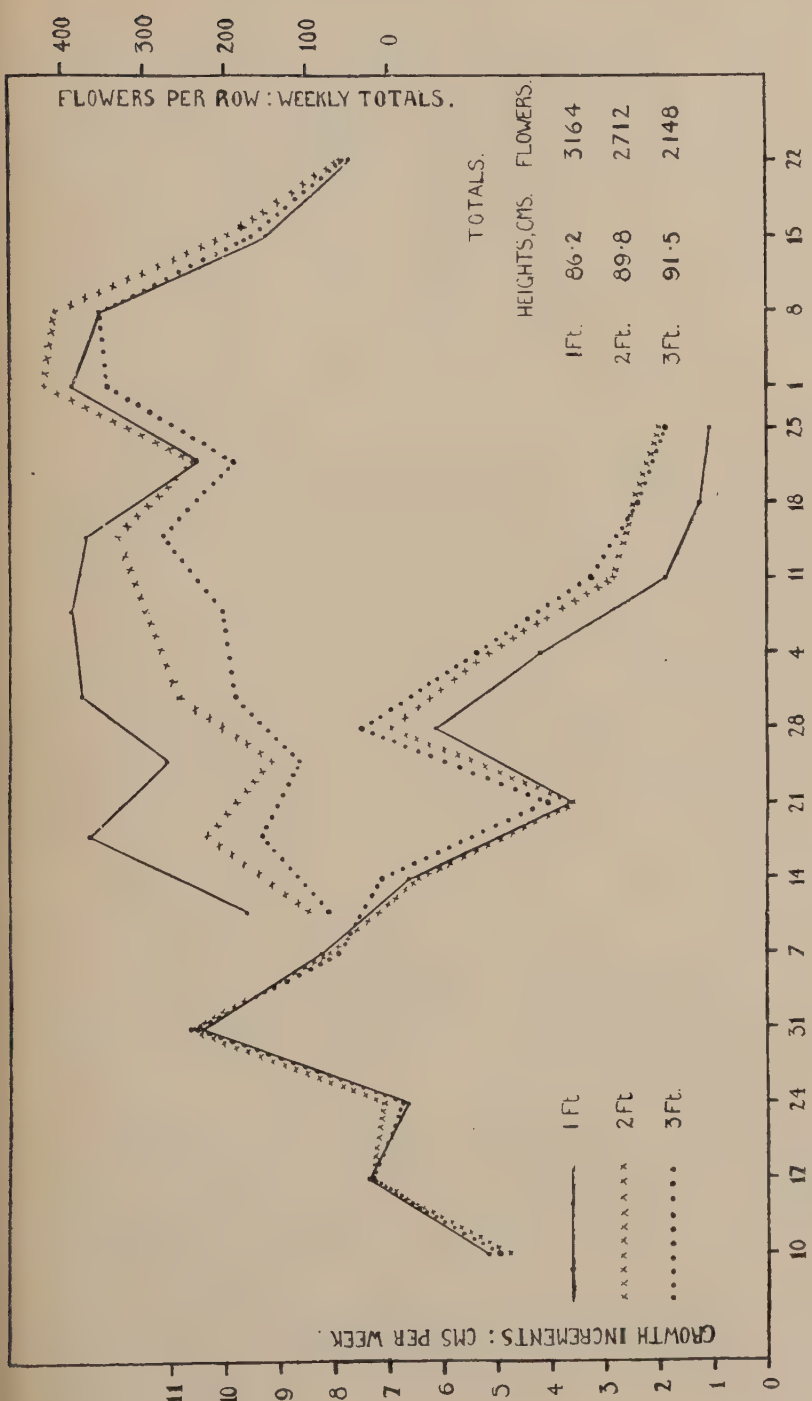


FIG. 1 SPACING EXPERIMENT, U. 4/4, GROWTH AND FLOWERING.

TABLE VI.

SPACING EXPERIMENTS.

Planting date.	*Spacing.*	*4/4 yield seed cotton per acre, lbs.*	*Standard error of difference between two.*	*H.77 yield seed cotton per acre, lbs.*	*Standard error of difference between two.*
October 17th	1 ft.	918	18·6	884	33·9
	2 ft.	804		800	
	3 ft.	592	68·9	653	45·2
December 4th	1 ft.	433		561	
	2 ft.	327	43·8	435	46·5
	3 ft.	294		353	

In the early planting only four of the six blocks could be used as one was damaged by white ants and another spoilt by excessive growth in one corner. The differences between the spacings, however, are large and all highly significant for both strains. It will be noticed that both strains have given approximately the same yields, except at the 3 feet spacing, where H.77, owing to its greater size, has out-yielded 4/4.

The Standard Error in this experiment was worked out separately, for 1 foot and 2 feet spacings in one case, and 2 feet and 3 feet in the other, as the 3 feet plots were much more irregular than the others, especially in the case of 4/4. Thus the inclusion of the 3 feet plots gives a *Standard Error for the experiment*, 4/4 at the three spacings, of 60·3 lbs. per acre. This figure would give an erroneous idea of the significance of the difference between the 1 foot and 2 feet yields.

In the later planting the 1 foot spacing is well ahead of the 2 feet and the differences are highly significant. The differences between 2 feet and 3 feet are smaller and not satisfactorily significant. It will be seen that H.77 is well ahead of 4/4, at all spacings, in spite of the latter being an earlier type. The superiority is due to the fact that it made a definitely stronger growth.

The whole question of spacing, in actual practice, is complicated by variations from season to season, not only in climatic conditions but also in the incidence of insect pests. The effective season, the period during which the plant puts on the crop that is actually harvested, varies enormously in this country. It may be short or long, early or late, and there appears to be no possibility of judging beforehand which it is likely to be. A short early season, as this year, definitely favours close planting. The same applies to cases where the later crop is largely destroyed by bollworm or stainer. On the other hand,

where the early setting is small or badly damaged and the main yield is from later pickings, wider spacing is an advantage.

What is required is some knowledge of the spacing, for any soil and district, that is likely to give the best average results over a number of years. There has been a tendency amongst the farmers of this area, during the past six years, to widen their spacing up to $1\frac{1}{2}$ feet or 2 feet according to the nature of their land, the inter-row spacing being generally $3\frac{1}{2}$ feet. Early bollworm is not uncommon and, with damage by jassid to the late crop now negligible, they find this wider spacing an advantage: they lose little on early pickings and gain a good deal on later ones. Of course, in a late season due to very late planting, a closer spacing is adopted.

Another important point in favour of wide spacing is the fact that it is better for opposite extremes of rainfall. With very dry conditions a closely spaced crop exhausts the soil moisture more rapidly, and undoubtedly suffers more than one at a wider spacing. With wet conditions close spacing commonly gives a more tangled mass of growth, unproductive except on the top, owing to the lack of light and air inside, and prone to damage from bollrot. Examples have been seen where, after an experience of this kind, farmers have gone to the other extreme and have thinned out their next crop to 3 feet spacing.

Wide spacing is open to the objection that a full stand is necessary to get a full crop, since a gap represents more of a dead loss. With spacings up to 2 feet, however, except with very poor growth, there is little loss on this account unless the stand is really bad.

TIME OF PLANTING.

A time-of-planting experiment was carried out in which five plantings were made, roughly at three-weekly intervals, from September 21st to December 14th. Two strains were used, U.4/2 and U.4/4, the arrangements of the plots being similar to that of the spacing experiment described above.

The results were very striking, each successive planting showing a big drop in yield, but unfortunately the figures cannot be accepted at their face value since jassid was a disturbing factor. The earliest plantings were in a condition to breed up this pest very early in the season. It became abundant and started to attack the later plots, scattered over the same block, long before these would have been affected in the ordinary way. There is no doubt that the later plantings suffered appreciably in this manner, and to an increasing extent as they became later and later. This cannot be looked upon as a legitimate

result of late planting, but it is not easy to see how it can be avoided in an experiment of this nature.

The actual figures for yield are not given, since they would be misleading in view of the effect described above. From observations on the plots throughout the season, however, there is no doubt that the same general result would have been obtained apart from the intervention of jassid, which only exaggerated the differences. Both strains behaved in exactly the same manner, the rate of falling off being much the same for both. The yields from 4/4 were decidedly less than from 4/2, however, amounting to roughly 80% of the latter for each planting.

Effect of Soil Treatment and Climatic Conditions on Plant Development.

By O. V. S. HEATH.

Effects of Soil Treatment.—Mention was made in last year's Report of the effect of previous fallowing in depressing the early growth of cotton. During the previous season (1928–29) experiments were laid down to test out this matter.

One of these experiments consisted merely of leaving a strip of fallow across the middle of a field of mealies, the whole field being ploughed early before the spring rains and planted with cotton (single-plant selections) during the present season. (It should be noted that whereas the mealies land ploughed up very rough and lumpy, the land that had been fallowed was friable and gave a comparatively smooth tilth.) The effect upon the seedling growth was most marked, the cotton following mealies growing vigorously while that following fallow made very poor growth indeed. This resulted in a very poor stand in the latter, as the small slow-growing plants laid themselves open to grasshopper and other insect attack for a longer period. Weekly growth measurements were made upon a plot that lay across the dividing line between mealies and fallow, ten plants being measured in each half of the plot. The growth curves, as well as the initial and final mean heights are shown in Fig. 2. It will be seen from these how very much more vigorous was the early growth of the cotton following mealies. Also that although the cotton following fallow grew better toward the end of the growing period, it did not quite catch up with that following mealies.

The other experiment consisted of two strips, one being left fallow and the other planted with mealies during the season 1928–29. Across these were three other strips of which the middle one was winter-ploughed in August, before the spring rains, while the other two were not ploughed until spring (mid-October) after good rains had fallen.

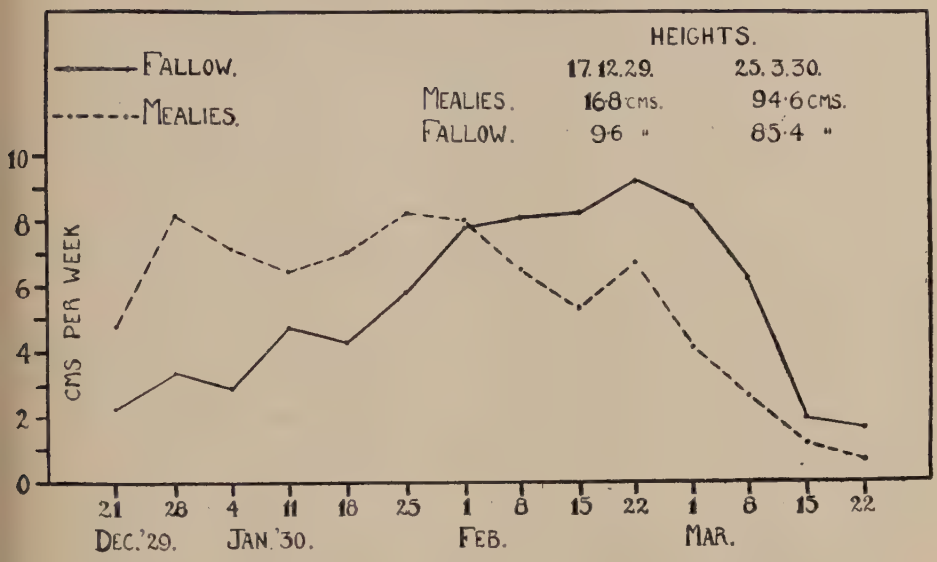


FIG. 2 COTTON AFTER FALLOW AND MEALIES – GROWTH INCREMENTS.

In this way four " treatments " were obtained which will be described in this Report as " Fallow Winter ", " Fallow Spring ", " Mealies Winter " and " Mealies Spring " respectively. The winter ploughing after mealies turned up large lumps and left the land very rough, whereas after fallow the soil was much more friable, owing to a higher moisture content, and fell down as a comparatively smooth tilth. When the spring ploughing was done the soil was very friable and a very smooth tilth resulted both on the mealies and on the fallowed land. The whole experiment was machine-planted with cotton of the strain U.4/2 on October 26th, and a fair stand was obtained at $3\frac{1}{2}$ feet between rows and 28 inches in the row.

Two-daily and daily observations of growth and flowering, as well as weekly bolling records, were made. Soil moisture contents were determined after each fall of rain and then at weekly intervals until another fall occurred. Maximum and minimum soil temperatures were read daily. (Owing to lack of time the soil moisture and soil temperature determinations were confined to the two treatments " Mealies Winter " and " Fallow Winter ".)

The object of these records and observations was partly to find the effects of the different treatments in the experiment, and partly to examine the effects of climatic conditions, as measured by meteorological data, upon plant development. The latter subject is dealt with separately below.

About a month from the date of planting differences between treatments began to be visible, the seedlings on the strip that had been fallowed being on the whole less advanced than those on the strip that had been under mealies the previous season. Later there was a good deal of irregularity, patches of aphis occurred over the experiment, and the differences between treatments became less obvious to general inspection. In spite of this, however, the results were quite useful though less striking than those of the small experiment described above.

When the plants were about five weeks old, twenty "average plants" were selected in each of the four treatments. These plants were selected and measured as described in the section on "Plant Development and Climatic Conditions" of last year's Report. Their mean heights and standard errors were as follows:

Treatment.	*Mean Height.*	*Standard Error of mean.*
Fallow Spring	8·8 cms.	0·16
Fallow Winter	8·8 „	0·14
Mealies Spring	11·3 „	0·17
Mealies Winter	11·8 „	0·20

Of these mean heights both the "Mealies" treatments are very significantly greater than the "Fallow" treatments. The "Mealies Winter" is barely significantly greater than the "Mealies Spring", ($P = 0{\cdot}055$).

The plants were measured on alternate days throughout the growing season and daily flower counts as well as weekly records of good and bad bolls opening were kept for the same plants. Any plant becoming damaged was replaced by another of as nearly as possible the same size and habit as the original one. Soil moisture contents were determined at 6 inches and 12 inches depths for the "Mealies Winter" and "Fallow Winter" treatments. Five samples were taken on each treatment at each depth, and the moisture contents, per cent. of oven-dry weight of soil, determined. The five determinations generally showed a remarkable degree of uniformity. Maximum and minimum soil temperatures were measured with narrow thermometers of the "Six's" type made by Casella and Co. These were placed in celluloid tubes at 6 inches and 12 inches depth in the "Mealies Winter" and "Fallow Winter" treatments.

The growth and flowering curves (smoothed to overlapping groups of three two-day means) are shown in Fig. 3.

It will be seen that the cotton on the land which had been winter ploughed after mealies made much better early growth than that on

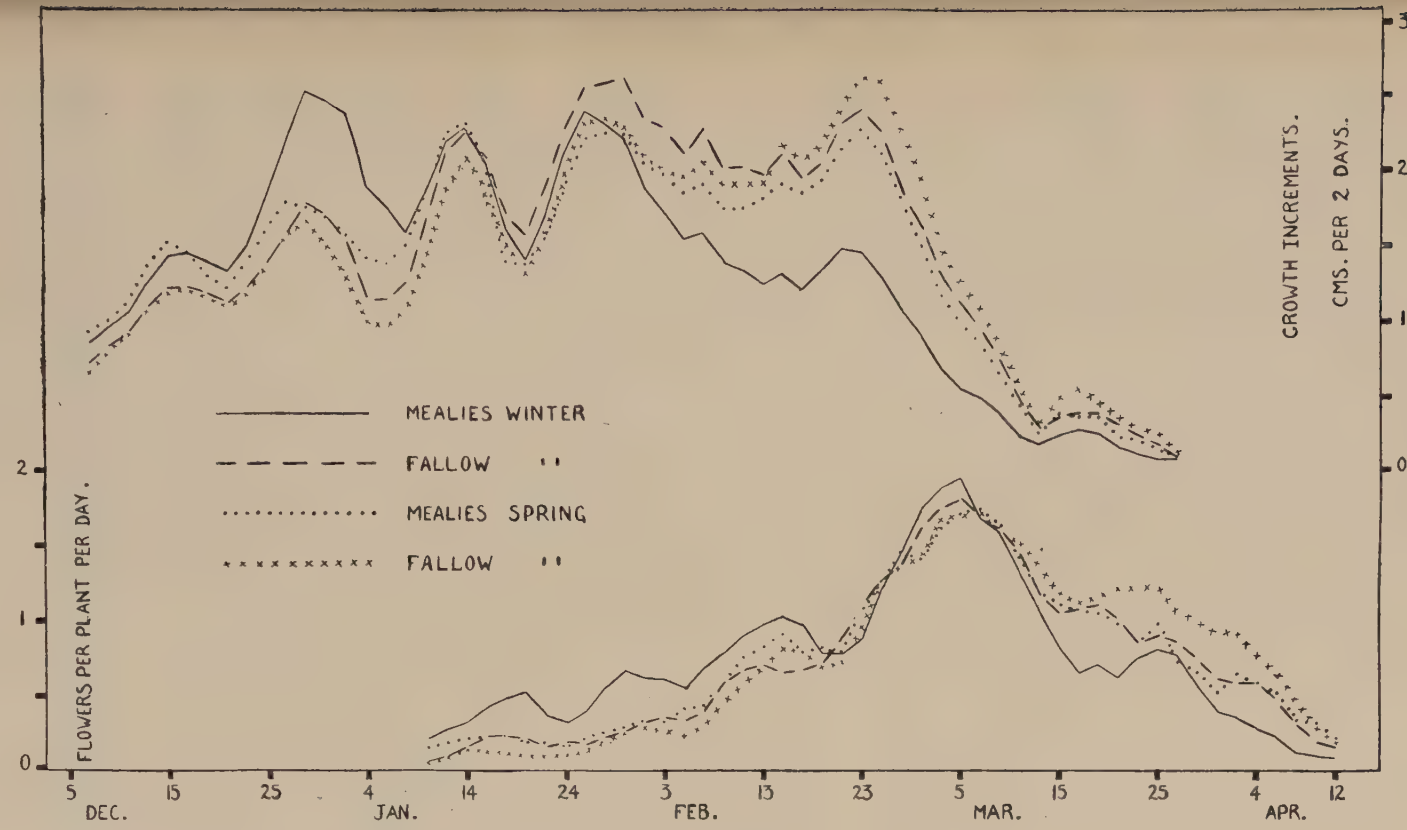


FIG. 3. COTTON AFTER FALLOW AND MEALIES, WINTER AND SPRING PLOUGHING, —— —— 2-DAILY GROWTH AND DAILY FLOWERING, (SMOOTHED).

any other treatment. As a result of this it grew much less toward the end of the growing season. This same effect of earliness is shown, but in a far less degree, by the growth curve of the " Mealies Spring " treatment as compared with the " Fallow Spring ". The " Fallow Winter " growth curve shows a slight tendency to be earlier than the " Fallow Spring." By far the most striking effect is the way in which the " Mealies Winter " growth curve stands away from the other three. Since the " Mealies Winter " was the only treatment that had rough ploughing it appears that the main effect is due to roughness of ploughing. The " Mealies Spring " and " Fallow Spring " curves, however, show a difference in the same direction with no very noticeable difference in the nature of the ploughing. Whether this is due to some effect of the mealies other than on the soil texture is quite uncertain at present.

The mean heights at the end of the growing season and their standard errors are given below. None of them differs significantly from the others.

Treatment.	*Mean Height.*	*Standard Error of mean.*
Fallow Spring	90·0 cms.	2·4
Fallow Winter	92·0 „	2·4
Mealies Spring	91·8 „	2·8
Mealies Winter	87·6 „	4·7

Twenty plants is really too small a number for flowering and bolling records. The flowering curves, however, show differences between treatments similar to those in the growth curves, but somewhat smaller in amount. Here again the " Mealies Winter " is much earlier than the other three treatments, and the " Mealies Spring " is slightly earlier than the " Fallow Spring ". The total number of flowers per plant produced during the season was almost the same for all treatments.

The bolling curves were somewhat irregular owing to the small number of plants. They showed, however, the same tendencies as the growth and flowering curves. The total number of bolls opened per plant during the season was practically the same in all treatments.

An interesting difference between treatments was found to exist with respect to the soil temperatures. The maximum soil temperatures at 6 inches depth were consistently higher (sometimes as much as 3°F.) in the " Mealies Winter " than in the " Fallow Winter " treatment.* (See Fig. 4.)

* This higher maximum soil temperature in the " Mealies Winter " treatment was confirmed by means of other thermometers inserted to 6 inches depth in various positions on the " Mealies Winter " and " Fallow Winter " plots and read at about the time of the maximum temperature.

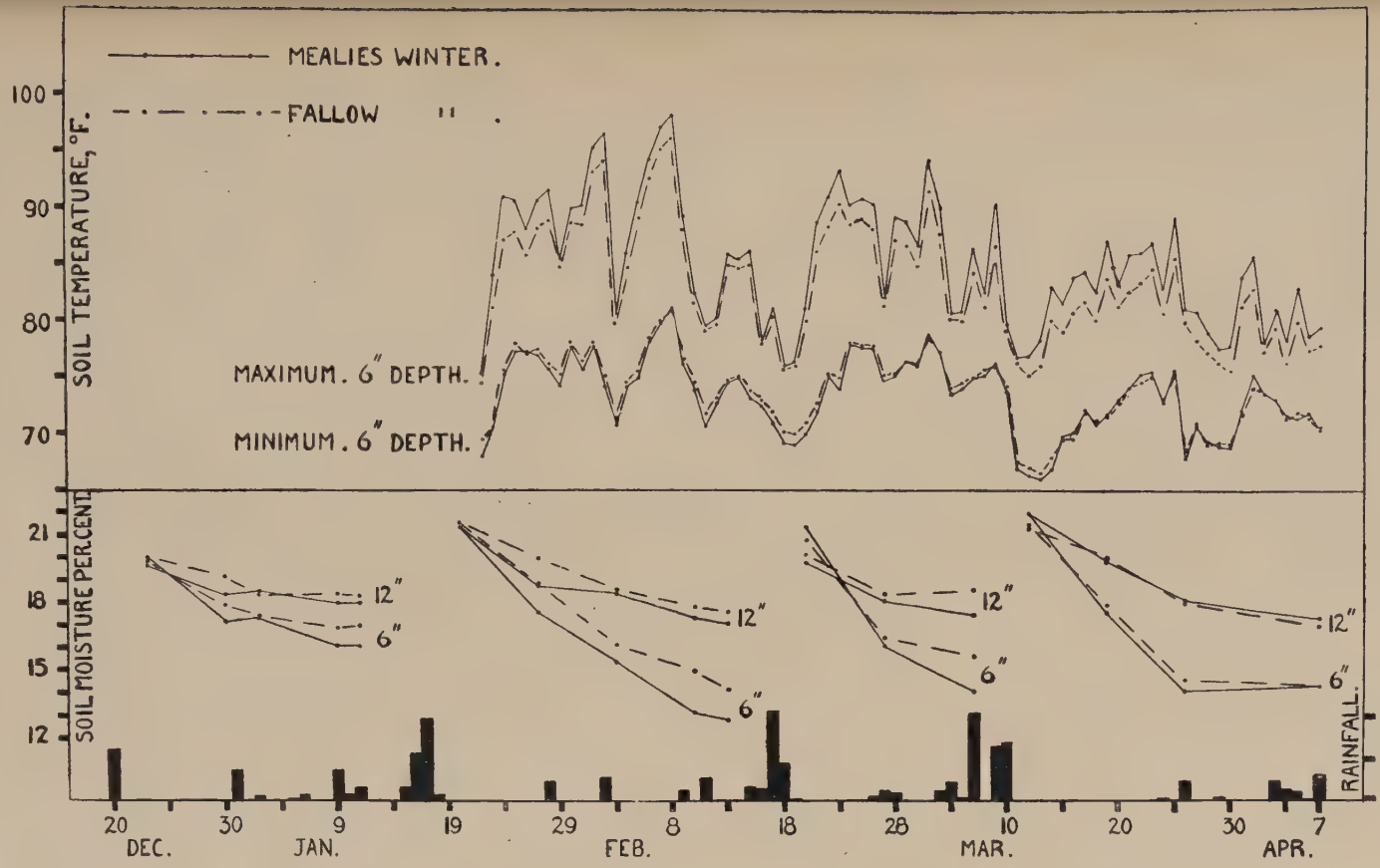


FIG. 4. COTTON AFTER FALLOW AND MEALIES — SOIL MOISTURE AND SOIL TEMPERATURE.

The minimum soil temperatures at 6 inches depth show no consistent differences and are almost identical for the two treatments. The 12-inch soil temperatures, both maximum and minimum, also fail to show any consistent differences between treatments. It is thought that the maximum temperature difference at 6 inches may have been due to differences in packing and moisture of the soil, and it is hoped that further work may shed some light on the matter. But whatever its cause, the higher maximum soil temperature on the "Mealies Winter" treatment may well have been one of the reasons for the earlier growth of the cotton on that treatment. This seems especially likely in view of the intimate connection between growth-rate and temperature observed at this Station.

Another factor in which the treatments were found to differ was soil moisture. The curves given in Fig. 4 show that, except after the growing season was over, the soil of the "Mealies Winter" treatment dried out more rapidly after rain than did that of the "Fallow Winter" treatment. This was also probably a matter of packing of the soil. As the season was on the whole a wet and cool one, with an abundance of soil moisture, this more rapid drying out on the "Mealies Winter" treatment may have helped to promote earlier growth.

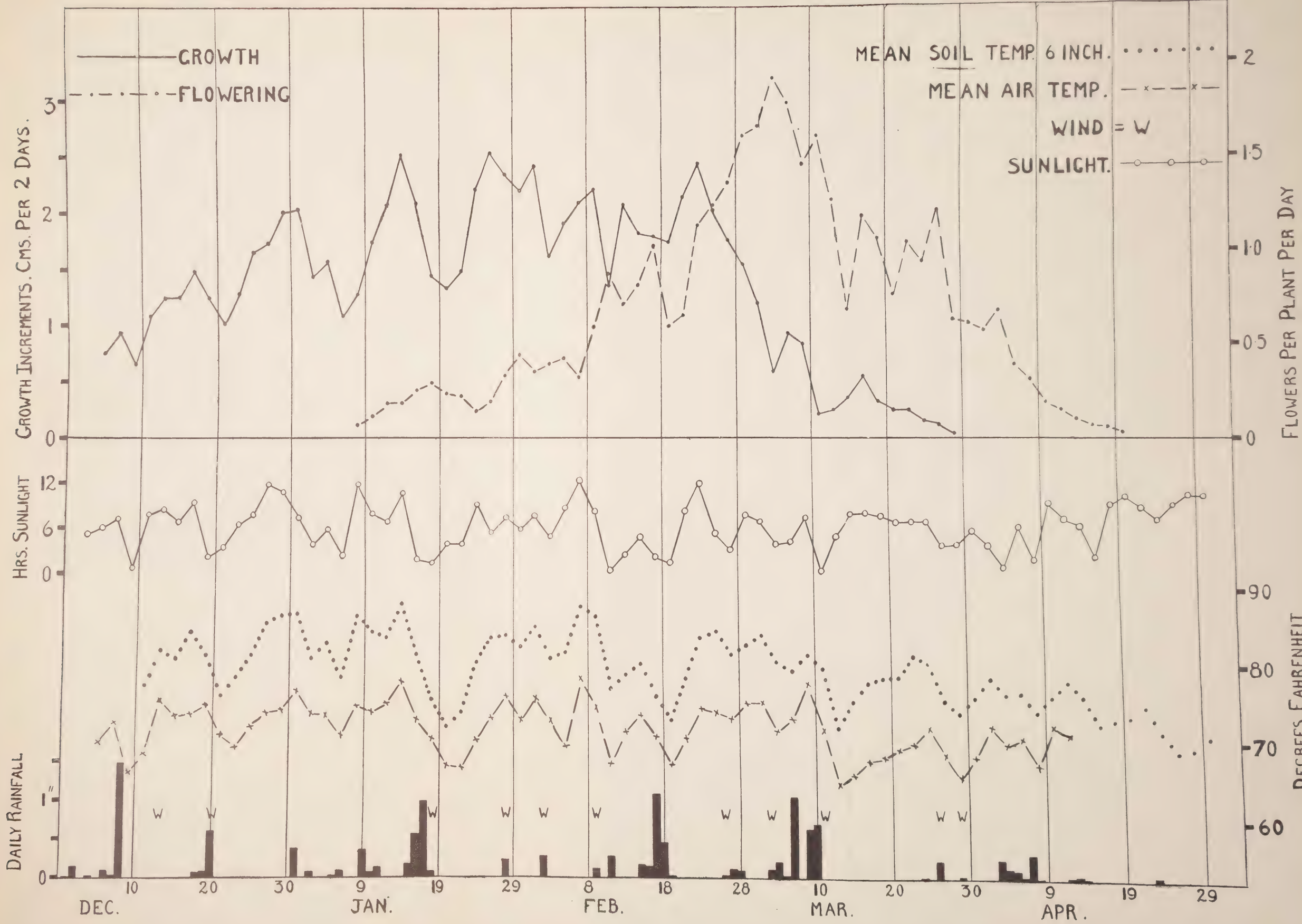
The results for the season 1929–30 thus indicate that, with the soil at this Station, the depressing effect of fallowing on the early growth and development of the cotton plant is mainly due to the manner in which the land ploughs up. That is to say, the effect is probably chiefly a matter of soil texture. Differences in soil temperature and rate of drying out are probably brought about by differences in texture, and may be partial causes of the effect upon growth and development.

This work will be continued and extended during the coming season.

Plant Development and Climatic Conditions.—For the purpose of comparing plant development with meteorological data, the two-daily growth increments and also the daily flowering rates (two-day means) were averaged for all four treatments of the experiment described above. In this way figures derived from 80 plants were available, and, in addition to the improved accuracy so obtained, the fact of using different treatments gave a wider basis for comparison.

The growth and flowering curves (unsmoothed) are shown in Fig. 5, together with sunlight, mean soil temperature at 6 inches depth, mean air temperature, rainfall and wind. The mean soil temperature given is the average of the maximum and minimum. The mean air temperature was obtained from thermograph charts as described in last year's report. The sunlight was measured with a Campbell-Stokes sunshine recorder.

Fig. 5. Plant Development and Climatic Conditions, 1929-30.



Other data examined in this connection were evaporation, measured with an open pan at ground level, maximum and minimum soil temperatures at both 6 inches and 12 inches depths, and soil moisture contents also at 6 inches and 12 inches depths.

With regard to the short period fluctuations in growth-rate the most important factor would appear to have been temperature, the 6-inch soil temperature curve especially showing a great resemblance to the growth curve. The 12-inch soil temperature curves were very similar to the 6-inch curves, but with fluctuations of smaller amplitude, so they are not shown. The soil temperature, mean air temperature and sunshine curves all show a good deal of resemblance to one another and must of course be correlated to a considerable extent. Of all these factors, however, the soil temperatures give the best fit with the growth curve. Rain does not appear to have had much effect on short period fluctuations in growth-rate except in so far as it caused a fall of temperature and hence a temporary slowing down of growth. These results, then, confirm the conclusion reached for the season 1928–29 that temperature is the most important factor in determining the short period fluctuations in growth-rate of cotton at Barberton.

The short period fluctuations in flowering also follow the temperature curves to a considerable extent but, in most cases, with a lag of about two days. This provides some confirmation for the conclusions reached for the season 1928–29, namely, that the factors favourable to growth also favour flower opening (as distinct from flower-bud production), but need about two days to take effect. There has not been time to investigate the correlation between climatic conditions and the laying down of flower buds for either of the last two seasons.

Further work will be carried out on these lines during the coming season.

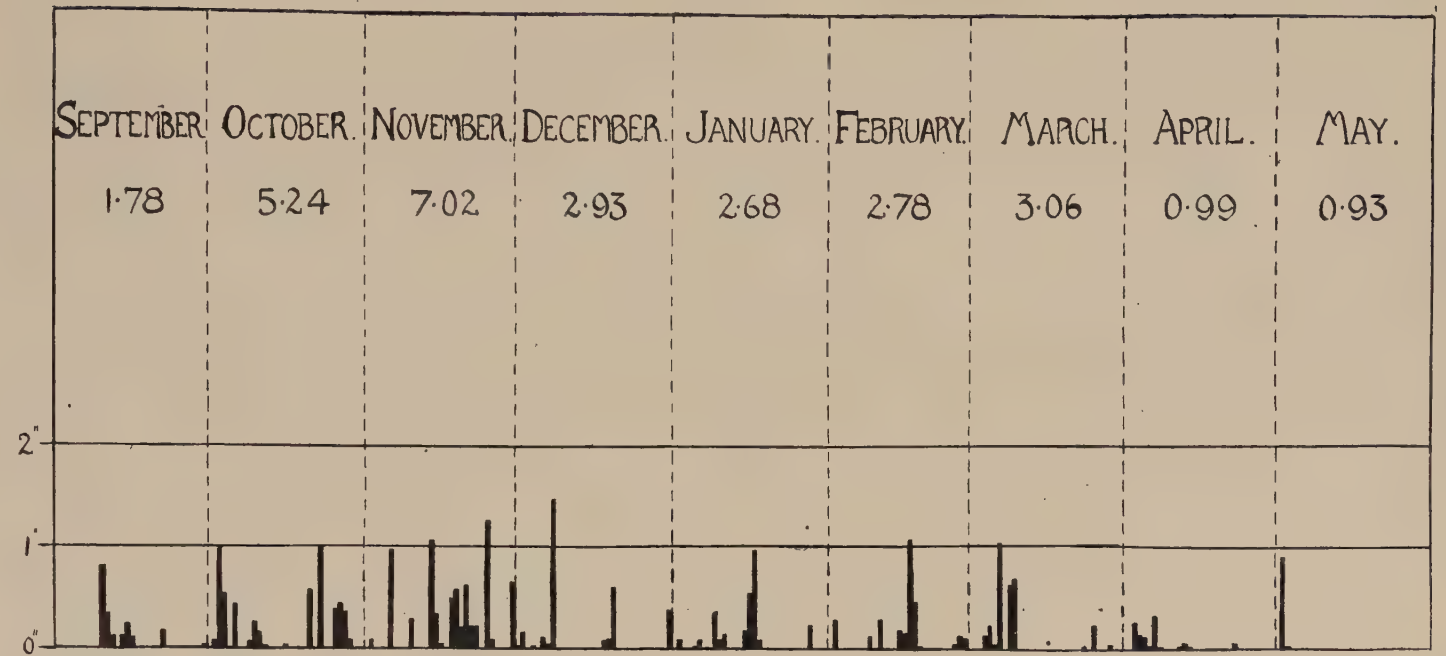
BARBERTON.

Daily Rainfall, Season 1929–30.

	July.	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*June.*
1	—	—	—	—	—	0·02	—	—	—	—	—	—
2	—	—	—	0·06	0·06	0·15	0·07	0·28	—	—	0·91	0·09
3	—	—	—	0·99	—	—	—	—	—	0·25	0·02	—
4	—	—	—	0·53	—	0·02	—	—	0·12	0·13	—	—
5	—	—	—	—	—	—	0·01	—	0·22	0·12	—	—
6	—	—	—	0·41	0·96	0·10	0·08	—	0·04	0·03	—	—
7	—	—	—	—	—	0·04	—	—	1·05	0·31	—	—
8	—	—	—	—	—	1·49	—	—	—	0·01	—	—
9	—	—	—	0·05	—	—	0·35	0·11	0·64	—	—	—
10	—	—	0·80	0·25	0·28	—	0·07	—	0·70	—	—	—
11	—	—	0·32	0·15	—	—	0·13	0·27	—	—	—	—
12	—	—	0·10	0·01	—	—	—	—	—	0·03	—	—
13	—	—	—	—	—	—	—	—	—	0·05	—	—
14	—	—	0·10	—	1·06	—	—	—	—	0·01	—	—
15	—	—	0·21	—	0·33	—	0·16	0·17	—	—	—	—
16	—	—	0·09	0·02	0·03	—	0·55	0·15	—	—	—	—
17	—	—	—	—	—	—	0·97	1·08	—	—	—	—
18	—	—	—	—	0·49	0·07	0·07	0·45	—	—	—	—
19	—	—	—	—	0·58	0·08	—	0·01	—	—	—	—
20	—	—	—	—	0·20	0·60	—	—	—	—	—	0·09
21	—	—	—	0·56	0·63	—	—	—	—	—	—	—
22	—	—	0·15	—	0·21	—	—	—	—	—	—	—
23	—	—	—	0·99	0·21	—	—	—	—	0·05	—	—
24	—	—	—	—	—	—	—	—	0·02	—	—	—
25	—	—	—	—	1·26	—	—	—	—	—	—	—
26	—	—	—	0·37	0·07	—	—	0·04	0·23	—	—	—
27	—	—	—	0·44	—	—	—	0·12	—	—	—	—
28	—	—	—	0·35	—	—	0·22	0·10	—	—	—	—
29	—	—	—	0·06	—	—	—	—	0·04	—	—	—
30	—	—	0·01	—	0·65	—	—	—	—	—	—	—
31	—	—	—	—	—	0·36	—	—	—	—	—	—
Total ...	—	—	1·78	5·24	7·02	2·93	2·68	2·78	3·06	0·99	0·93	0·18

Total rainfall for year 27·59 inches.

DAILY RAINFALL. SEASON 1929-30.



Report on the Work on Rotation Crops.

BY

F. S. PARSONS.

Introduction.

The work on rotation crops during past seasons has been largely confined to growth trials in observation plots or in small field areas. The information obtained from these trials indicated that a few, out of the many crops grown, were probably suitable for rotation with cotton in the districts concerned. The need for more exact observations of these promising crops was apparent and the present report deals with the first season's work on various plot tests of them.

It was felt that the strains in hand of the various crops to be grown should be supplemented, and as a result of enquiries, some valuable additional material was obtained in time for growing during the present season. Some of the strains were procured through the Corporation's Headquarters in London, others through the courtesy of Mr. M. A. Bailey in the Sudan, and of the Canadian, Southern Rhodesian, and South African Departments of Agriculture. Mr. Ducker in Nyasaland also kindly forwarded seed supplies. On the whole there was a good representation of different varieties of the principal crops, although it is felt that it would be advantageous to secure additional material from original sources, for instance, soya beans and sunflowers.

All the crops under consideration have been viewed in their relation to cotton-growing from the standpoints of soil fertility, seasonal management, and pests and diseases, in addition to their revenue value. Maize is probably the only rotation crop, of those retained under test, with which farmers in the cotton areas generally are acquainted, so that rather full particulars about other crops are required, including information as to market conditions, both local or abroad. The produce from the rotation crops likely to be grown extensively will probably require outlets on overseas markets; for one important crop, soya beans, no interior market has been developed as yet. It has therefore been necessary to obtain authoritative advices about market conditions for the several crops concerned before embarking on extended programmes of work. Information on this subject, based on samples of produce, has now been accumulated and in consequence the work has proceeded with more confidence.

Season.

Rain fell on fifteen days in October and fifteen days in November. The distribution and volume of the rainfall during these two months made the conditions too wet, and this, combined with periods of cool and occasionally cold weather, retarded growth. There were intervals

during both months when planting conditions were suitable and experiments with crops having relatively protracted growing periods were seeded down in these two months, commencing on October 14th.

The moisture penetrated deeply during October and November and provided abundant reserves which were probably not greatly depleted until late in the season. None of the succeeding months was rainy but, as the rainfall table shows, until April each provided a good fall about the middle of the month of the order of $1\frac{1}{2}$ inches, with intervening and moderately heavy showers. Except for very late plantings, conditions favoured the progress of the rotation crops from the moisture point of view. On the whole this was also true of temperatures. The weather was only seasonably hot on occasional days which occurred in January and February. Otherwise the days were rather on the cool side and a few really cold nights were experienced from March onwards.

The planting programme was extensive and seedings were made at various intervals from October 14th to March 23rd.

EXPERIMENTAL WORK.

The experiments for which yield data are given, unless otherwise stated, were all set out with four to six repetitions of each treatment in randomized blocks and the data have been analysed by Fisher's variance method.

SOYA BEAN (*Glycine max.*).

Soya beans have been grown successfully on trial plots in various parts of the cotton areas for the past four years. It is a crop with an increasingly large and fairly stable world market. At the present time the great bulk of the total crop is taken by the oil trade. The extraordinarily high nutritive value of the bean is now being utilized, however, through the introduction of new processes whereby the soya bean is suitably prepared in various forms for human consumption.

TABLE I.

WORLD PRODUCTION OF SOYA BEANS.

	Average for the years :				
	1923-24-25 Tons.	1926 Tons.	1927 Tons.	1928 Tons.	1929 tons forecast.
China	2,400,000	2,682,400	3,600,000	5,250,000	5,250,000
U.S.A.	145,000	165,000	175,000	200,000	250,000
Japan	550,000	550,000	550,000	550,000	580,000
Java & Dutch East Indies	—	—	—	—	120,000
Other Asiatic Countries ...	—	—	—	—	400,000
					6,600,000

The figures quoted are taken from "The Soya Bean and the New Soya Flour," C. J. Ferrée. (Heinemann.)

According to Midsummer advices soya beans were valued in London at £11–£12 per long ton, c.i.f. At the time of writing the prices quoted are considerably below these figures in common with the universal drop in the prices offered for agricultural produce.

Most strains of the soya bean shatter their pods when these dry out. Some of the strains under observation at Barberton dropped their seed following pod shattering in so wholesale and rapid a manner that the beans could not be harvested in any way economically. In certain other strains the seed is retained long enough to render a full harvesting possible provided nothing occurs to hamper the picking of the whole crop as soon as it is ready. In order to do this, of course, labour, weather and other conditions must be favourable for the operation, and these naturally cannot be relied upon with certainty. Comparatively non-shattering strains exist, however, and it is a fortunate circumstance that one, and very probably two, strains, highly resistant to shattering have appeared amongst those under test at Barberton. Fully ripe stands of one strain, Yellow 1, have remained unharvested for periods up to seven weeks under wet and dry conditions without shattering more than an occasional pod. This is a definite case of resistance which has been displayed equally for the past three seasons. The strain itself is one of the highest yielders of the present lots and produces an extra large yellow seed. A sample of this seed gave on analysis, at the Imperial Institute, an oil content equal to that of the common run of commercial samples.

Granted provision of seed from a non-shattering strain, such as Yellow 1, the management of the crop has presented no difficulties. Details of this are omitted as their chief interest is to local farmers.

It is considered that on the best yields obtained here with present material the crop can be grown at a small profit, if marketed abroad at normal prices. To what extent interior markets may arise appears to depend on the interest taken by oil seed crushers in South Africa and the introduction of soya flour milling, etc., by new processes.

It is very difficult to find suitable rotation crops for local conditions. The need for these is urgent and the fact that an otherwise suitable rotation crop may do little more than return working costs, measured in terms of the sale of grain, should not preclude its use in conjunction with others. There are, however, good indications that higher yields than those shown in the following Tables will arise from the single-plant selections which have been made and further investigations on spacing, inoculation and fertilizer treatments may well result in improved yields.

Variety Test.—The three best yielding strains in a variety test at Magut last season were tested again in this experiment. There were six repetitions of each variety set out in randomized blocks. The seed in each case was inoculated.

TABLE II.

SOYA BEAN VARIETY TRIAL.

Variety.	*Mean Yield per acre. lbs.*	*Maturation Period Sowing—Harvest. days.*	*Nodulation.*
Haberlandt ...	914	102	Only one or two large nodules at root crown.
Mammoth ...	1,009	123	,,
Southern ...	1,180	145	,,

The standard error of the difference of two variety means is 20·6. Differences between varieties for various values of P:—

P=·01	P=·02	P=·05
65·3	56·9	45·9

Nodulation in the root system is seen to have been negligible. Piper and Morse* state that nodules are not found on plants of the Haberlandt variety in the United States. The named varieties of soya beans which we have were mostly procured in South Africa and it is probable that the identity of some has been confused.

Haberlandt.—At harvest 85–90% of the plants were carrying fully ripe pods and shattering was absent. Only occasional semi-green leaves were borne by ripe plants and the plants could have been stacked if required without danger of becoming mouldy.

Certain guard rows between plots were left unharvested for observation on their shattering behaviour over a period of time. Within nine days after reaping the plots for yield data 25% of the pods in these guard rows had shattered and within seventeen days practically everything had shattered. It was observed that when the ripened pods of shattering varieties were wetted by rain they generally shattered badly on drying out.

This variety produces a desirable seed but has been discarded owing to low yield and tendency to shatter.

Mammoth.—In this case it was observed that the early ripened pods commenced to shatter before 60–70% of the total pods of the crop

* "The Soya Bean," Piper and Morse. McCraw-Hill Book Co., Inc.

could be harvested; approximately 50% of these later pods being green and the remainder semi-ripe. The same behaviour was noticed in observation rows elsewhere. The plants could not be pulled into windrows as the loss from shattering *in situ* would be too heavy. They could not be gathered into heaps in order to localise shed seed, much of which could be recovered, as the amount of green leaf matter retained by plants carrying ripe pods is sufficient to set up fermentation in the heaps. The variety has been discarded for these reasons.

Southern.—The variety known as "Southern" was procured from the Magut Station, where it had been remarked as a comparatively non-shattering strain in previous seasons. In the present instance the yields have suffered a big reduction because the seed was mixed and there were plants, amounting to 25% of the stand, scattered throughout the plots, which belonged to earlier maturing and shattering varieties from which only a small portion of the seed was collected and weighed for inclusion in the total, as an approximation to the yielding power of Southern. Haberlandt and Mammoth seed contributed most of the mixing and as the seed of these closely resembles the seed of the Southern variety, they were not seen during the examination of the seed before planting. The Southern variety appears to be identical with the non-shattering strain Yellow 1.

Time of Planting Experiments.—Seed from the Yellow 1 strain was used in these experiments. There were five planting dates, commencing on October 26th. At each planting date four plots were sown in rows 2 feet 6 inches apart and four other plots in rows 2 feet apart. The experiment was thus a combination of inter-row spacing and time of planting. The treatments were set out in randomized blocks with suitable provision against edge effect.

The main objects of the experiment were to get accurate data on the growth periods and yields of the strain in relation to the varying influences of the season over a range of plantings. Data were also required to indicate when the seeding down and harvesting of soya bean lands fits in best with cotton in those particulars, it being accepted that cotton would receive prior attention.

In the present instance, in addition to estimating gross yields and observing vegetative growth behaviour, the quality of the grain produced under different conditions for growth has been examined by analysing the contents of batches of 200 pods per spacing treatment for each planting date. The results are summarized below.

TABLE III.

TIME OF PLANTING COMBINED WITH INTER-ROW SPACING.—SOYA BEAN.

Planting Date.	*Inter-Row Spacing*	*Mean Yields per Acre. lbs.*	*Maturation Period Sowing—Harvest. Days.*
October 26 ...	2′	1,322	144
	2′ 6″	1,335	144
November 14 ...	2′	1,230	136
	2′ 6″	1,200	136
December 8 ...	2′	1,320	114
	2′ 6″	1,336	114
January 10 ...	2′	1,169	108
	2′ 6″	940	108
February 21 ...	Failure.		

The drop in yield from the November 14th planting is probably due to a higher percentage of seed being retained in the hulls at thrashing time—it is noteworthy that portions of the pod are broken transversely without splitting if the atmosphere is not really dry when thrashing is undertaken. The point was not fully appreciated until this instance occurred.

Inter-row spacing is seen to have exerted no influence on yield except for the January planting. In this instance the difference is highly significant. Although both crops for this planting date were fully ripe about the same time, that at the closer spacing commenced podding earlier, due no doubt to a relationship between greater root competition and failing moisture. Moisture was very short for the latter part and cut down the production at the wider spacing accordingly.

Heavy rains fell on ripened pods in these plots at different plantings without causing damage. The non-shattering types of soya bean fare decidedly better in this respect than any other bean crop grown here.

Analysis of the seed production in 200 pods, taken at random for each spacing from all plantings, showed no differences between treatments, whether spacing or planting dates, in number and weight of seed, percentage of aborted ovules or proportions of one, two, and three seeded pods, until the January 10th planting. The records for the January 10th planting showed a drop of 10% in the numbers of seed per 200 pods taken and a reduction in seed weight of 21%. The falling off in yield and seed weight from this planting must be attributed to poor moisture conditions. The character of the short growing season experienced by this late planting would probably affect the oil content

of the seed adversely, according to other workers. The only effect of the too wet conditions in October and November was to prolong the growing period.

An inter-row distance greater than 2 feet is of advantage for implemental cultivation. There having been no increase in yield from the 2 feet rows under good conditions this season, wider rows will be adopted for the cultivated soya bean crops. Whether it may be advisable to drill in the crop in close rows with a modified grain drill should however be investigated. Broadcasting was not satisfactory this season owing to the difficulty of covering the seed and getting the right moisture conditions.

The Yellow 1 strain grown in the plots requires about three weeks longer to mature under like conditions than all but one of the other soya bean lots under test. It may however be sown after cotton planting is finished with every likelihood of being harvested before cotton picking is general.

Observation Rows.—Fourteen varieties were sown in suitable plots for observation purposes. To a large extent these constituted the chosen few from a large number introduced into South Africa, but, as previously implied, additional lots are being secured. Only five of these varieties are being carried on for further observation in the coming season. Information on them is summarized below.

TABLE IV.

Soya Bean Varieties.

Name.	*Maturation Period. Days.*	*Mean No. Pods per Plant on 40 Plants.*	*Weight 100 Seeds. Grammes.*	*Weight of Beans from 200 Plants. lbs.*	*Shattering Behaviour.*
Morse ...	97	59·5	19·2	9·0	Moderately resistant.
Brownie ...	104	83·0	13·2	10·50	„
A.K. ...	97	71·0	15·7	11·50	„
Yellow 1 ...	135	71·0	22·5	10·50	Highly resistant.
Yellow 2 ...	135	110·0	25·0	17·75	„

Two hundred plants were collected at random in each observation plot. These plants were thrashed by hand and the seed weighed for comparison of yielding power, seed weight, etc., between the varieties as shown in Table IV. The discarded lots were all uniformly bad for shattering.

Single Plant Selections.—Selection work in soya beans is facilitated by the fact that the percentage of natural crossing is very low and colouration of the seeds is an excellent character for recognizing hybrids.

A number of single plant selections were taken in the observation plots during the season. All of these held the seed well after ripening fully. If the promise of these selections is upheld next season higher yielding material will be available immediately for multiplication. Selections were taken of a few plants of a fodder type with a view to their use as green manures or hay.

Seed Multiplication—Yellow 1.—Seed of this strain was available with which to sow five acres for multiplication purposes. Seed from this area is being issued to farmers for their preliminary growth trial of the crop on a small scale. The multiplication plants were rogued severely during flowering and again when ripening off. A quantity of excellent uniform seed was derived, after suitable screening, from the multiplication field.

Yellow 2.—This strain was grown in a small observation plot only. It is very like Yellow 1 in habit of growth and resistance to shattering, but the plants are uniformly larger and much more fruitful—*see* Table IV. The strain will be employed in a variety test next season and seed will be multiplied as far as possible.

Pests.—Rootknot caused by nematodes appeared in a number of cases. The species of nematode responsible has not been notified at the time of writing. Two different nematodes are reported as causing injury to soya beans. These are *Heterodera radicicola* and *Heterodera schachtii.* Should the nematode in question prove to be either of these it will be necessary to procure varieties of soya beans which are resistant to nematodes, *e.g.*, the Laredo and three other unnamed varieties known to be resistant.

In all cases where rootknot was observed the crop borne by the affected plants was quite normal in quantity and quality. The nematodes mentioned above however are known to propagate freely in the roots of the soya bean plant and as *Heterodera radicicola* causes rootknot of cotton the need for resistant varieties is clear, if the nematodes are identified as the species named.

Termites.—White ants destroyed occasional plants before they had ripened off. In some areas they might do considerable damage.

Pod Worm.—Small pink worms were discovered eating into seed in the pods to an inappreciable extent. These were found to be heavily parasitized. The identity of worm and parasite have not been notified to date.

Diseases.—All plantings were singularly free from bacterial and fungoid diseases.

Tepary Bean (*Phaseolus acutifolius*).

These beans are also called pearl and small white haricot beans. They are known on local and overseas markets. The Empire Marketing Board advised in December last that tepary beans could have been sold for £20 per long ton, c.i.f. London, at that time, but this high price was due to a shortage in the American Bean crop. They reported that the market requires a somewhat larger bean, and that when supplies of larger beans are offering in ordinary amounts the tepary bean would probably be taken only in limited quantities at lower prices. America uses this type of bean for canning purposes, but discouraging reports were received on samples of this bean submitted to that trade. A sample of the bean that is favoured for canning purposes was sent to us. This is grown in Eastern Europe and is known as the Danubian bean. The Danubian bean was grown at Barberton last season with very indifferent results, but it will be tried again next year using the seed produced at Barberton from the imported sample.

Importers in London stated that it was very difficult to give a nominal value for tepary beans in view of bean prices having been upset for the last two or three years. They considered however that the ordinary price would range from £12–£13 per long ton c.i.f. In times of scarcity tepary beans have sold very freely in London. There is reported to be an annual shortage of beans there during the period prior to the arrival of the new crop from Eastern Europe and the Far East. The Eastern Europe crop usually commences to arrive about the end of September and Japanese beans come on the market in January. Importers consider that August and September would be the best months for tepary beans from South Africa to arrive in London as better values and larger absorption could be expected then. It would be quite convenient to ship South African tepary beans for arrival abroad during these months.

Interior markets may be expected to absorb fair quantities of this bean, especially if it should be purchased in bulk for native ration purposes at the mines. Arrangements have been made for tests of its suitability for this purpose.

However local markets may react in the future, it would appear that favourable opportunities exist for the disposal of the crop on export markets at values which would leave a small margin of profit. This would not apply according to advices, unless only well cleaned beans were shipped. If uncleaned beans were accepted a cost of about £2 per ton would be deducted for cleaning abroad.

A sample of these beans was analyzed for the Corporation at the Imperial Institute, and the data are given below as the beans are not widely known and the figures may be of interest.

TABLE V.

ANALYSIS OF TEPARY BEANS.

	Barberton Sample. %	*Burmese Sample.* %
Moisture	10·3	12·0
Crude Protein	24·1	23·6
Fat	0·9	1·3
Carbohydrate (by. diff.)	58·6	57·2
Crude Fibre	3·1	2·7
Ash	3·0	3·2
Nutrient ratio	1 : 2 : 5	1 : 2 : 5
Food units	121	119

The beans are free from cyanogenetic glucosides.

Additional remarks are that tepary beans have a high food value and compare very favourably in that respect with haricot beans, lentils and peas.

The present season's work with tepary beans consisted largely of combined time of planting and inter-row spacing experiments. These were set out in the manner described for soya beans. The inter-row spacing distances in this case were also 2 feet 6 inches and 2 feet. The rows were sown thickly with a hand planter and were later thinned down to an inter-plant distance of 4–5 inches.

TABLE VI.

TEPARY BEANS.

COMBINED TIME OF PLANTING AND INTER-ROW SPACING EXPERIMENT.

Planting Date.	*Inter-Row Spacing.*	*Days to free flowering.*	*Maturation Period Sowing—Harvest. Days.*	*Yield per acre. lbs.*
October 17	2′	44	110	1,420
	2′ 6″	44	110	1,480
November 4	2′	46	109	1,484
	2′ 6″	46	109	1,450
November 30	2′	33	103	1,290
	2′ 6″	33	103	1,240
December 24	2′	32	90	1,254
	2′ 6″	32	90	1,270
January 10	2′	30	95	818
	2′ 6″	30	95	780
February 25	2′	29	97	357
	2′ 6″	29	97	340
March 13		Observation plot—no yield.		

Inter-row spacing treatments exerted no influence on yields over the wide range of growing conditions experienced.

The November 30th planting encountered wet weather at harvest time and considerable loss resulted through bottom pods becoming mouldy and sprouting. These badly damaged pods were not collected, which explains the drop in yield reported for these plots.

The last three plantings did not pass through the conditions experienced generally as the rains, especially during March, were very much shorter than usual. Ordinarily January and February planted tepary beans would probably receive ample moisture and warmth for the production of a full crop. In fact these are the months into which plantings fit best, as dry weather for harvesting is most likely later. The crop requires about 100 days only from seeding to harvest; beans sown in February would consequently be harvested in plenty of time to make use of moisture for ploughing before the land drys out and sets in the winter season.

The contents of 200 pods per spacing treatment at each planting date were examined for numbers of seed, seed weight, aborted ovules and discoloured and diseased seed. These did not vary with the spacing adopted. The earliest planting, which experienced the wettest conditions, produced the highest percentage of discoloured seed, this being 10·3%. The lowest record for this from any spacing was 8%. The quantity of discoloured seed in the produce obtained over the range of growing conditions experienced was sufficient to give the grain a somewhat unfavourable appearance. Much of this discoloured material may however be removed in a screener owing to its swollen proportions or irregularity of shape. The point is important because the prices paid vary greatly according to the general cleanliness and appearance of the produce. The percentages recorded in the present cases probably nearly represent the conditions which have and generally will be experienced.

The percentages of aborted ovules were greatest in the early planting, being 8·7% for the October plots, but they dropped off in successive plantings, for which moisture was less abundant, to under 1%. Seed numbers per pod and seed weight varied little throughout. The only effect of rather excessively wet conditions in October and November was to delay podding somewhat. The plant thrives well unless the conditions are unusually severe.

Insect Pests and Diseases.—The large cantharides beetle, which is a voracious consumer of flowers, appeared in great numbers on the earliest plots and persisted throughout the season. Despite great damage, yields of approximately 1,500 lbs. per acre have been secured.

This season the cantharides beetle was a pest on practically all the leguminous crops and work on control measures was started.

In several cases a serious form of leaf affection was observed. This is considered to be a mosaic disease and a suggestion was received from Dr. S. C. Harland of the Cotton Research Station, Trinidad, when visiting here, that the disease is insect borne, as thrips and white fly were commonly found amongst the plants. It is proposed to investigate this point in the coming season as time of planting may have an important relationship with the seasonal distribution of an insect vector.

LIMA BEANS (*Phaseolus lunatus*).

A dwarf variety of these beans was grown at Barberton last season for the first time, with poor results. The seed, which came from Nyasaland, is all white, including the hilum, and is well favoured on overseas markets, where it is sold under the name of Madagascar bean. The quotations in the July 4th, 1930, number of the "London Grain, Seed and Oil Reporter," for Madagascar beans was £32 per long ton, afloat. Sampson* in his report on rotation crops in Nyasaland, states that at the time of his enquiries, 1927, the bean was valued at £25 per ton. The commercial status of this bean appears to be rather outstanding.

Suitable observation plots were planted at intervals during the season under review. The growing conditions for these plots differed considerably and gave opportunities for learning something more about the bean under local conditions.

Last season at Barberton the plants lost nearly all their pods including full-sized green pods. The same pod-shedding behaviour was observed from the first settings of flowers in the October and November plots of the present season, but not in subsequent plantings to any appreciable extent. The plots planted in October and November experienced much wetter conditions than the others and the pod shedding in these cases was probably due in part to moisture conditions.

In reply to enquiries about experience with Lima beans elsewhere, Ducker in Nyasaland states that the dwarf Lima beans planted at the break of the rains, about the first week in December, grow and flower luxuriantly but fail to set seed. He attributes this failure to physiological shedding combined with the attack of pests, particularly the large cantharides beetle, which is also the chief pest of many legumes there. After the main rains in Nyasaland later sowings of the Lima bean gave crops of 500–600 lbs. of beans per acre. The Chief of the Agricultural Service in Madagascar states that there too best results

* "Report on the Characteristics of Several Crops that may be suitable as Rotation Crops with Cotton in East Africa, and the Possibilies of Marketing Them in this Country." By H. C. Sampson, C.I.E., Empire Cotton Growing Corporation. London, 1927.

are secured from Lima beans sown at the end of the rains, and that the moisture requirements of the plant are met from the moisture stored in the soil before planting. If the growing period in Madagascar is extra hot or if an excess of rain falls during growth, fertilization in the flowers is poor and pods shed wholesale.

An examination of the flowers and pods carried by shedding plants in the early plantings of this season at Barberton showed (*a*) a high percentage of aborted ovules, (*b*) the presence of sterile pollen in great quantity, and (*c*) an apparently diseased condition of advanced embryos. In the latter case no bacterial or fungoid organisms were found by the Department of Agriculture, Pretoria, to whom the material was submitted for mycological examination. The irregular appearance of the unripe seed seemed to be caused by unfavourable growth conditions. Considering the behaviour of the first crop of pods in the two earliest plantings, our experience this season was much like that of Madagascar and Nyasaland. A few plants in the early plots looked as if they were resistant to the general shedding. These were tagged, but proved on further observation to be non-resistant.

The dates of planting were October 17th, November 14th, December 4th, January 10th and March 13th. On January 15th (*see* Table VII for flowering data, etc.), practically no evidence of fruiting remained in the October and November plots, except for a few bottom pods containing malformed seed. The plants were green and healthy, however. By February 28th the same plants were carrying a new crop of pods. These did not shed and constituted a good first picking from the plots concerned. The subsequent cropping of these plots is given along with that of later plantings in Table VII.

TABLE VII.

DWARF LIMA BEAN—OBSERVATION TIME OF PLANTING PLOTS.

Dates of Planting.	*Date of free flowering.*	*Planting to Flowering, Days.*	*Picking Dates.*	*Planting to Picking. Days.*	*Percentage of Crop Picked at Picking. Date.*	*Approximate Yield per Acre. lbs.*
Oct. 17	Nov. 4	34	Mar. 17	151	23·9	
	Feb. 4	110	Apl. 14	179	29·3	
	(Second		May 30	225	18·4	
	Setting)		June 24	249	18·4	1,245
Nov. 14	Dec. 24	40	Mar. 17	123	20·4	
	Feb. 4	82	Apr. 14	151	28·6	
	(Second		May 30	197	30·6	
	Setting)		June 24	221	20·4	1,120
Dec. 4	Jan. 12	39	Apr. 2	119	35·7	
			May 30	177	38·0	
			June 24	201	26·3	960
Jan. 10	Feb. 13	34	June 24	165	100	753
Mar. 13	Hoed out—no crop. Plants ceased growth by June 30th.					

Pod setting commenced on the December and January sown plants about January 12th and February 13th respectively. Dry weather was experienced then and later, although the records show that there were occasional good rains at rather long intervals until the end of the season. Pod shedding was practically absent throughout these two plantings. It was found also that the October and November sown plants held on to the pods from the second lot of flowers set from February 4th onwards. The retention of the pods thus occurred when the soil moisture content was reduced very considerably below that of the early months. The rain that fell later was not heavy at any time and as no further shedding resulted, it would appear that over-wet conditions cause pod shedding in the Lima bean. The more extensive growth of the early plants enabled them to set a second larger crop, once less free moisture was available. The cantharides beetle, known locally as the C.M.R. beetle, played a very large part in the fruiting and growth behaviour of the plant. This beetle eats the flowers wholesale. It was present during the whole season in great abundance. The flower stalks, especially of the early flowers, are carried upright above the foliage where, being exposed, they are readily attacked by the beetle. The loss of flowers from beetle damage stimulated the production of more and denser vegetative material which hid and protected flowers produced in the interior of the plant on additional flower stalks. It was not until these distorted growth increases appeared in each planting that pods had a chance to set, the setting occurring mainly from interior flowers. The maturation date for the plantings do not show the normal periods for the cropping of the plant because of the intervention of the beetle. When interior flowers were given protection by increased leaf matter the proportion of pods set to flowers was high in the regions concerned and clusters of pods were seen. These were carried low down on the plant and by their weight were often brought to rest on the soil, which is undesirable. As the plant aged gradual leaf fall set in. The leaves which dropped into the plant settled at the bottom, caught up in a mass of stems mingled with pods. As a result the wet weather caused the pods to become mouldy, but this did not develop harmfully in any case during the season.

The beetle is therefore responsible for altering the normal growth habit of the plant, and indirectly for endangering from mould the crop which escapes destruction by it. This is better understood from observation on the plant's growth when protected from the pest in a wire gauze cage when the amount of destruction of the unprotected crop is also realized. The caged plants pursued an uninterrupted flowering and podding course, producing a full ripened crop weeks

before unprotected plants of the same sowing date alongside. Furthermore the caged plants were open, rather spreading, and carrying an evenly balanced crop. No damage occurred from mould as shed leaves were not held in the open plant. The caged plants ripened 25–30 fully formed pods as against an average of 8–10 pods on outside plants. The caged plants were sown on January 10th.

The crop requires to be picked at different times as it ripens off gradually, and although dry pods did not split open at all readily on the plant, numbers will split open or half open and drop the seed if left for a long time. In the case of the last planting the picking was taken as a whole without loss, probably because the weather was cool with no alternate moistening and drying of the pod wall. It is probable, as indicated by the more even ripening off under cages, that the number of pickings required and their cost, would be lessened by about one-half if the cantharides could be substantially reduced.

The beans were thrashed out readily by a 24-inch beater bar machine, the seed being very clean and practically free from blemishes.

No diseases were observed and the only pest of consequence was the already mentioned cantharides beetle. Work on control measures was started during the season. Various bait traps, emulsions and poison dusts were ineffective, but a determined effort will be made to reduce this pest as it is responsible for heavy damage to nearly every legume crop.

Considerable space has been devoted to discussion of the behaviour of this crop as it appears that, with better understanding of its growth requirements combined with some control of its main pest, it will be a useful and profitable rotation crop.

Sunflowers.

In past seasons yields from small field crops of sunflowers have ranged from 1,200 to over 2,000 lbs. of seed per acre. The crop has been grown solely for the seed. These yields, which compare very favourably with such published figures as have been received here, have been obtained from mixed seed producing a high percentage of non-productive plants. The plants have grown well in different seasons and, for a hoe crop, have required a minimum of attention until harvest time.

Sunflowers as a crop are rather exhausting to the soil, both on account of their plant food requirements and owing to the fact that very little of the plant material is returned to the soil. In a relatively short time most soils in the low veld which had borne heavy crops of sun-

flowers would probably require mineral fertilizers and green manuring, much of the cost of which would have to be charged against the sunflower crop. In view of this, and of the market conditions, which are discussed below, unusually high yields from this crop would be necesssary to enable it to be grown profitably.

Market Conditions.—A certain amount of sunflower seed is sold on interior markets each season. Some of this is re-sold abroad, the South African export figures for sunflowers being a total of 225 short tons for the period 29/12/29 to 9/8/30. Quotations on interior markets for the past few seasons have seldom been high enough to encourage the growth of the crop and these markets are easily overstocked. On the other hand it appears from information received from London brokers, that, at times, the seed may be marketed abroad to fair advantage. There are two markets abroad, one for bird seed and the other for oil extraction purposes. In the latter case the residue is used in live-stock foods.

Imports of sunflower seed into the United Kingdom have dropped from 33,000 long tons in 1924 to 449 long tons in 1928 ; of the latter only 21 tons were imported from British countries. The United Kingdom market is solely for bird seed at present and, as seen, the quantities absorbed are negligible. The oil seed crushers on the Continent, however, buy very large quantities. Their chief source of supply is Russia and the quantity and quality of the Russian product are the factors that determine the prices offered. At the commencement of this season it was reported that the Continental sunflower market was largely overstocked because South Russia was marketing such large quantities of good seed, the result being that values were lower than they had been for the last few years. When these conditions obtained the prices were £10–£11 per long ton c.i.f. Continental ports. Using the above valuations as a basis for computation it is considered that sunflower seed could be grown under local conditions and marketed on the Continent at a small profit, but only if yields and quality were really good.

Work with sunflowers is being continued, as both yields and quality are thought to be capable of much improvement and present valuations do not reflect the prices ordinarily offered.

Spacing Experiment.—An inter-row distance of three feet appeared to be quite suitable from previous observations and all plantings of sunflowers were made accordingly this season. In the present experiment the inter-plant spacings under test were 12 inches, 18 inches, and 24 inches. There were five repetitions of each treatment set out in randomized blocks.

A striped seed variety from the Magut Station was sown as this had given a superior yield over other material in a variety test and the seed was less mixed. A large quantity of obviously off-type seed was removed, however, before planting. The variety requires about $4\frac{1}{2}$–5 months in which to mature. The plots were sown on November 12th, with an expected ripening sometime in April. The heads in the 12-inch spacing were ripe however by March 24th, the maturation period being shortened by dry weather in February and March. Pollination conditions were good (the plant is self sterile) as an abundance of insects visited the plants throughout flowering.

The plants in the 12-inch plots were conspicuous by reason of their greater height from the commencement. These plants flowered seven to ten days earlier than the others and made less sturdy growth. Differences in growth and flowering between the 18-inch and 24-inch plots were very slight.

TABLE VIII.

SUNFLOWER SPACING EXPERIMENT.

Spacing Interval.	*Yield Seed per Acre. lbs.*	*Mean Weight of Seed—on 200 Seeds per Spacing Treatment. Grammes.*
12″	1,532	18·2
18″	1,680	20·6
24″	1,650	21·2

The standard error of the difference of two treatment means is 62·3.

Difference between treatments for various values of P.

P.01	P.02	P.05	P.1
209·0	180·4	143·6	115·8

TABLE IX.

FREQUENCY ARRAYS OF DIAMETERS OF SUNFLOWER HEADS—IN INCHES.

SUNFLOWER SPACING EXPERIMENT.

Spacing Interval.	*Number of Observations.*	*Inches.*										*Mean.*	*S.D. Mean.*
		1	2	3	4	5	6	7	8	9	10		
12″	90	—	1	1	16	28	27	15	2	—	—	5·46	1·126
18″	103	—	—	—	3	23	27	29	16	4	1	6·46	1·240
24″	78	—	—	—	1	7	20	25	16	8	1	7·00	1·21

TABLE X.

FREQUENCY ARRAYS OF THE DIAMETERS OF NON-PRODUCTIVE AREAS IN THE CENTRE OF SUNFLOWER HEADS—IN INCHES.

SUNFLOWER SPACING EXPERIMENT.

Spacing Interval.	*No. of Observations.*	*Inches.*												*Mean.*	*S.D. Mean.*
		·75	1·00	1·25	1·50	1·75	2·00	2·25	2·50	2·75	3·00	3·25	3·50		
12″	89	1	8	4	12	16	31	9	6	1	1	—	—	1·80	·137
18″	104	6	9	7	10	22	16	14	9	5	4	1	1	1·86	·191
24″	77	10	18	2	9	7	11	7	9	1	1	1	1	1·65	·215

The non-productive area refers to a portion of varying extent in the centre of the sunflower head in which, in the present case, only aborted ovules were present. This was waste material. The proportions of the total area of the heads occupied by waste material of this description, as determined from the mean diameters for the three spacing treatments, are given in the following percentages :—

12-inch spacing ... ... 10·88%
18-inch spacing ... ... 8·29%
24-inch spacing ... ... 5·48%

The cutting of the heads at harvest time and the thrashing are the most costly operations in the management of the crop. It is clear therefore that, other things being equal, the fewer heads there are per unit area to be cut and dealt with the better, so that the widest compatible spacing should be adopted. In the present case the widest spacing has given an equal yield. A consideration of Tables VIII, IX and X shows moreover a marked difference in size and fruitfulness of heads and seed weight produced at the three spacing intervals, all of which increase with the spacing intervals. The seed from the wider spacing was also more regular in size.

When the ratio of the area of the non-productive portion to that of the whole head is high, as in the heads from plants spaced 12 inches apart, the thrashing and cleaning costs will be increased by reason of the higher percentage of waste to be dealt with, and the quantity of empty hulls escaping in the heavy seed during winnowing will be greater. In a poor growing season the dimensions of the seed and the percentage of waste would probably be adversely affected, in addition to yield, according to the root room available to the plants. The wider spacing therefore seems preferable in every way, although oil content has not yet been determined in this connection. Whether the spacing should be wider than 24 inches remains to be examined.

Time of Planting Experiments.—There were four planting dates as under. At each planting date four plots of a black seed strain and four plots of a striped seed strain were set out in a randomized block arrangement. The experiment was thus a combined variety test and time of planting investigation. The two strains used have been grown on a small scale by a few farmers and it was desirable to test their relative yielding powers over a range of growing conditions. The returns from the black seed strain was very poor in comparison for all plantings and it has been discarded.

The yields for the various plantings of the striped seed strain were as follows :—

TABLE XI.

SUNFLOWER—TIME OF PLANTING EXPERIMENT.

Planting Date.	*Yield per Acre. lbs.*	*Sowing to Reaping. Days.*
October 16	1,476	139
November 2	1,424	140
November 30	1,362	136
January 10	1,360	143

The October 16th and November 2nd plots experienced really wet conditions, the November 30th plots less so, whereas those of January 10th passed through a dry period. These differences in soil moisture conditions had no appreciable effect on the respective yields or maturation periods. Temperatures varied little.

Under different conditions for growth this strain of sunflower, having a full growing period of approximately 140 days, may be sown as late as January 10th and experience sufficient warmth for growth and ample insect activity for full fertilization.

The pre-flowering growth period of this strain, and of most of the other strains at Barberton, occupies about 70 days, the flowering period of the head about 18 days, and the ripening off period some 50 days. These periods were not influenced appreciably by the climatic differences covered by the experiment so that the January planted sunflowers flowered in late March. This meant that developing and ripening of the seed was not completed until May. We do not commonly get a useful rain in May as we did on the 3rd of that month this season—consequently conditions would probably be too dry ordinarily to permit of a full crop of January planted sunflower being reaped, and the oil content would no doubt be adversely affected if dry conditions persisted. Heavy rains on flowering heads, especially before these have drooped

well downwards, wash out pollen to such an extent that empty hulls may predominate in the heads. As a rule considerably more rain falls in March than in February and it seems advisable to arrange sunflower planting if possible sometime in early December or late November. The flowering or most of it would thus occur in February, and March rain may be more or less relied upon for soil moisture to carry through a crop which would then ripen off and be harvested in dry weather. The sunflower harvest would clash with the first cotton picking in some seasons.

Observation Rows.—Fourteen strains were set out in observation plots. Nine of these were new lots procured from abroad. The highest yielding lot, and the most uniform, is a black seed strain procured from Swaziland. Some bulk lots and selections were taken from most of the strains for growth in the coming season. These are white, black and striped seed strains with somewhat different growth periods. Samples of these are being forwarded to the Imperial Institute for analyses of oil content, acid value, etc.

Pests and Diseases.—No insect pests have appeared on the crop apart from one attack of American bollworm, which, although the worms were plentiful, caused little damage. The sunflower weevil has not been reported in South Africa according to advices from the Division of Plant Industry, Pretoria. Birds and rodents cause a certain amount of damage.

A leaf disease caused by a fungus, *Septoria helianthi*, damaged the bottom leaves which passed through the early wet months. Little of this was seen later in the season. The upper leaves of the affected plants were quite healthy and the yield was not reduced apparently.

SORGHUM.

Sorghum has received a good deal of attention in past seasons because of its drought-resisting qualities and partly no doubt because it is grown by the natives and, in general, appears to be a suitable rotation crop in the low veld. Numerous strains have been collected in South Africa and abroad for growth in observation plots and fields on the Corporation's Stations in South Africa. The results from these plots have not been encouraging from several points of view, but, at the commencement of the present season, a programme of work with sorghums was laid down which provided for tests of 17 varieties divided into groups according to their maturation periods, time of planting experiments, with short, medium and long growth period types, observation rows of 31 varieties, and numerous seed multiplication blocks of the more promising lots. At the outset it may be said that all

varieties grown for grain production were practically failures, most of them total failures. This is the only crop, of those tried out, which has been a complete failure, this loss occurring moreover in a good growing season. The reasons may be given briefly—stalk borer, aphids, rust and birds. As a result of this season's experience sorghums as a grain crop have been definitely dismissed from the rotation crop work. A few remarks may be made about the behaviour of one (90–100 day) dwarf variety. This variety, which has a habit of producing numerous suckers, was able to bring through one or more shoots free from borer attack. These produced heads of ripe grain giving an acre yield of 485 lbs., a loss on the crop, but, because of the plant's ability to elude borer and because it was comparatively free from aphids and rust, the seed is being handed over for trial in the Magut area and Southern Swaziland.

Fodder Sorghums.

In a season of low rainfall a greater weight of fodder may be expected from a close stand of certain sorghums than from maize, because of the drought-resisting qualities of sorghums. This is only true provided the stalk borer is not too active when the plants are in a young stage; according to our observations, this pest attacks sorghums much more heavily than maize. In the present season the stalk borer was particularly abundant in the months of October, November and December, but plots of sorghums sown for fodder on January 21st were practically free from the pest. Four varieties of sorghums were tested against each other in quadruplicated plots for weight of plant matter produced. These varieties are all noteworthy for their superior length of stalk.

The plots were sown in rows 2 feet apart, the inter-plant spacing interval being 12 inches. The returns of dry weight per acre for each variety given in Table XII were calculated on the air-dried basis.

TABLE XII.

Fodder Sorghums—Return of Dry Weight per Acre.

Variety.	*Yield per Acre. Dry Weight. lbs.*
No. 1	5,740
No. 2	3,938
No. 3	3,670
No. 4	2,338

Mean differences are highly significant in each case.

Fodder sorghum has been ensiled in pits with good results at Barberton. The possession of this reserve food material has been especially valuable in supplementing the pasture towards the end of the dry season—in fact, without it, at the present time (November) the draught oxen would not be in fit condition to prepare the land for seeding.

GROUNDNUTS.

Time of Planting observation plots were set out in the months of October, November, December and January. The main object of these was to see if " rosette " disease was less severe or absent depending on the time of year covered by the crop and on varied growing conditions. It so happened however that only very rare instances of plants affected by " rosette " disease were found in this season at any time. Work with groundnuts, in plots of this kind, is being continued.

The varieties under test have been reduced to three—Gudiatham, Spanish 9 and a Japanese variety. These gave approximate yields per acre of 20 bags (70 lbs.) in the present season. The varieties in question possess somewhat shorter, thicker and stronger peduncles than the others seen, which no doubt partially accounts for the higher yields recorded, as fewer nuts would be left in the soil at harvest time. The oil content of one of these varieties, Japanese, was outstanding in analyses made in a previous season.

MAIZE.

A certain amount of maize has been grown in the low veld cotton areas year by year. The crop cannot be said to have been profitable as a rule, rather the reverse. There is some doubt, however, as to how far this may have been due to unsuitable varieties and methods.

The crop is included in rotation experiments at Barberton, and at the other Stations, and work is being carried out to ascertain which variety is most suitable for local conditions.

It was considered that time of planting observation plots would be most useful, at the outset, as a means of learning something of the relative merits of a number of varieties commonly grown. Seven varieties were grown in such plots this season. The growing conditions were good for the greater part and the yields were higher than may be expected as a rule. Three of the varieties were relatively outstanding for yield, one particularly so. This variety, American White Flint, produced $2\frac{1}{2}$ bags to the acre more than anything else and over 7 bags more to the acre than some others, the actual yield being $14\frac{1}{2}$ bags. Other varieties are being obtained for tests against the above three.

A variety of maize procured from Bechuanaland during the season has a growing period of only 60 days. The plant is short and bears small cobs containing small, hard, grey-white grain. This variety may be of considerable value owing to its short growing period and should be suitable for close planting, from which good yields may be expected.

The maize produced locally is utilized mainly for native labour rations; consequently the type of the grain, viewed from market standpoints, is a secondary consideration in types which, though unsuitable for export, may give higher yields here.

The results from the season's work encourage the belief that much may be accomplished from the examination of varieties of maize with a view to getting one which is generally more suitable for the areas concerned.

Lentil.

The variety which we have been growing is considered to be a form of *Lathyrus sativus* L, the "chickling vetch" or "khesari" of India. At one time "khesari," when used for human consumption, was believed to cause a form of paralysis known as lathyrism. As a result of the work of Anderson, Simonson and Howard ("Indian Journal of Medical Research, 1923," X 3, p. 857, and 1925, XII 4, p. 613) it appears that pure seed of *Lathyrus sativus* is innocuous, but that the seed of *Vicia sativa* L, variety *augustifolia*, a common weed impurity, is the cause of the symptoms known as lathyrism.

This crop has been grown for two seasons and promises well both as a grain and as a soil improvement crop. At Barberton it requires about 140 days from planting to reaping and may thus be sown late. It appears to be suitable as a broadcast or drilled crop, and may be very useful for green manuring and cleaning purposes. Data have not been procured concerning markets for the grain abroad. A certain amount can be sold in this country at a profitable figure.

Sunn Hemp.

Three varieties were grown this season, *crotolaria striata*, *crotalaria usaramoensis* and *crotalaria juncea*. The two first named were quite unsatisfactory. *C. juncea* on the other hand appears to be our most suitable cover and green manure crop. There is at present a market for the seed at favourable prices.

Co-operative trials of the value of sunn hemp as a nitrogenous green manure are now being arranged. At the Barberton Station this season a broadcast stand produced 12 tons of green matter and 1,100 lbs. of seed to the acre.

CROP ROTATION EXPERIMENTS.

Arrangements have been made for commencement in the coming season of two rotation crop schemes. In one two-thirds of the area involved are occupied annually by cotton, the remaining third being devoted annually to crops of soya beans, tepary beans, sunflower and maize on equal areas. The other scheme requires one-half of the area to be planted to cotton annually and the remaining half to be planted to the four crops mentioned on equal areas.

COTTON INSECT PESTS.

BY

F. S. PARSONS.

Every year, as part of the general programme of work, certain observations have been made on the various insect pests of cotton in this country. The notes on these observations, as contributed to the annual volume of Reports from Experiment Stations, cover mainly the seasonal distribution of pests, their effect on the cotton crop, and the value of measures for control or evasion, such as trap crops, light traps, time of planting relationships, crop rotations and insecticides. These accumulated data are valuable; thus, it has been demonstrated that the provision of cotton trap rows in the spring season, as described in the Annual Reports, is an inexpensive measure that undoubtedly reduces the red bollworm and safeguards the bottom crop to a considerable extent. The remarks regarding cotton trap rows may be applied also to the black beetle (*Syagrus rugifrons*, Baly) that attacks cotton in these areas, although in the latter case the use of an insecticide, calcium arsenate, is necessary, together with rotation practices, if the best results are to be secured. In the examples cited some measure of success has been attained. In other instances the information obtained in past seasons, at the most, provides starting points for intensive work on stainers and bollworm. To this must be added the study of indigenous and imported parasites of the various pests with a view to their exploitation.

As the prosperity and expansion of the cotton-growing industry in South Africa very largely depend on the extent to which pests may be reduced, this work requires the undivided attention of investigators. The work on insect pests undertaken at Barberton during the past season was of this more intensive character. Such investigations require very considerable expansion and confirmation before definite results may be expected, and as the data from the season's work are

necessarily very incomplete, it is not proposed, at this juncture, to discuss the results obtained this season.

An additional laboratory was erected during the winter months to provide extra accommodation for the insect pest work. This is a four-roomed structure which is at present organized for the mass production of parasites of the red and American bollworms, particularly of the egg parasite (*Trichogramma lutea*, Girault) to which reference has been made in the Reports from the Magut Station. In this case breeding commenced on the acquisition of adults from bollworm eggs collected in the field in late September last and it is proceeding satisfactorily, after various preliminary difficulties in the way of temperature and humidity control had been overcome in the parasite and host chambers. Flander's technique*, evolved in California for the mass production of *Trichogramma minutum*, though somewhat modified in the present instance, is being employed for the multiplication of *T. lutea*, the host in this case also being the common grain moth, *Sitotroga cerealella*. The rate at which the parasite is being multiplied encourages the belief that sufficiently large numbers may be expected shortly with which to conduct investigations in the field. Concurrently with the exploitation of *T. lutea*, attention is being directed to a number of other parasites of the American bollworm, notably another chalcid egg parasite which was found to be very active during the late winter amongst irrigated crops.

By arrangement with the Department of Agriculture, Pretoria, two officers working with the Entomological Section, Mr. J. S. Taylor, and Mr. G. C. Ullyett, undertook investigations on cotton pests at the Cotton Breeding Station, commencing in September, 1929.

Mr. Taylor was afforded the laboratory accommodation and equipment required to continue work on *Microbracon brevicornus*, Wesm., as a parasite of the American bollworm, with which work his attention is now engaged. Mr. Ullyett has engaged, in collaboration with myself, in all the general programme of work, but latterly more especially in the investigations on parasites. Arrangements are now in force whereby Mr. Ullyett is working under the direction of the Corporation.

* J. Econ. Ent., 21, No. 3, p. 512, June, 1928.

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, MAGUT, NATAL, FOR THE SEASON 1929-30

BY

P. A. BOWMAKER.

Summary.

The amount of experimental work on the Station was considerably decreased in the season 1929/30 owing to the reduction in the staff at Magut. The work on cotton was confined to variety tests of U.4 Mixed Bulk, and its re-selections, and of certain of the Cambodia selections, with trials of Spacing and Time of Thinning. In the variety tests two of the re-selections from U.4 are well ahead of the Mixed Bulk.

A change has occurred in the district following the final winding-up of Candover Estates. A large area was not planted, but the purchase of the lands of the Estates by the Union Department of Agriculture for a land settlement scheme will eventually lead to closer settlement and a rather more intensive type of farming.

The need for definite rotation of crops has again been demonstrated in connection with control of the beetle (*Syagrus rugifrons* Baly), which is now becoming the pest of major importance in the district.

Without exception all cotton planted in the area was U.4. The season was moderately good, marked by fair planting conditions and heavy rains later in the year. The finish of the season occurred abnormally early, resulting in very little loss in grade from stainer damage.

Climatic Conditions.

The outstanding features of the season were the exceptionally good conditions for planting during September and the first half of October, and two very heavy rains occurring in January and March. A total rainfall of 4·04 inches was measured during September, spread over twenty days, with dull intervals between the rains. Very little of this was lost and it made a thoroughly good beginning to the season. The moisture in the top soil had joined up with subsoil moisture, making

conditions fairly safe for early planting. The continuous rain, combined with dull weather had the effect of bringing on a growth of weeds both on lands which had had cultivation during the winter and on others remaining to be ploughed. Generally speaking, it was not possible anywhere in the district to get on to ploughed land for further preparation, and during the early part of October some farmers were forced to cross plough their lands to deal with the weeds, a practice which is not usually carried out, with subsequent obviously beneficial results to the cotton crop.

The bulk of the planting in the district was carried out during October, about a month earlier than usual. Good germinations were obtained in most cases. Growing conditions were not good, however, during the latter half of October, as a fortnight of cold, dull weather was experienced, but a hot spell with showers at intervals in early November, gave the young cotton the stimulus it needed. December was a good growing month. There was a dry spell during the first half of January which gave all cotton planted on the thinner soils a setback. This was beneficial rather than otherwise, as up to the end of the year conditions had been too favourable to the growth of wood, at the expense of fruiting. The rains of January 15th, 16th and 17th, came at a good time, but their usefulness was not proportionate to their amount. Most of the cultivated land in the district is sloping, and the rains were so heavy that after the top layer of soil was thoroughly wetted, most of the rain ran off. The bulk of the crop was set after this rain. Conditions for fruiting were good until March 9th to 10th. Large numbers of bolls were already set, but the rains at this date caused wholesale shedding for some time afterwards, with the resulting quick ending to the picking season in June.

Cotton in the District.

In January the Candover Estates Ltd., were liquidated. It is difficult to say what will be the fate of their cotton lands during the next few years. Last season a small acreage was planted before it was definitely known that the Company was going into liquidation, but apart from this, and a small crop which was reaped from their stand-over cotton, their lands need not be considered in a review of cotton in the area for the past season.

The passing of Candover Estates is to be regretted, and it is felt that but for the advent of U.4, and the promise which it bears of a more prosperous time for the cotton farmer, a severe blow would have been dealt to the cotton-growing industry in South Africa by the liquidation of so large a concern. The Union Government, as represented by

the Natal Land Board, however, appreciates the possibilities of the district, and in January purchased the whole of the land of Candover Estates, comprising some 76,000 acres. Quite a large portion of this is irrigable, and work is at present in progress on a survey for a canal to be taken from the Pongola River. The non-irrigable portion has been split up into 29 farms varying in size from 1,500–2,000 acres, and about half of these are now in occupation.

In the Magut and Mkuzi areas some 4,100 acres were planted to cotton, which was without a single exception U.4. The seed obtained from the multiplication fields of the previous season was pooled and the pool augmented by supplies from the Barberton area, sufficient seed was thus available for all requirements.

As already mentioned, about 70 % of the crop was sown by the end of October. Cotton planted after this did not have a good rain until December 8th, and was at a critical age at the time of the heavy rains in March. The early-planted cotton in every case was a success, with yields of up to 1,900 lbs. seed cotton per acre, but the late-planted crops suffered from the March rains and from the drought after April 4th. The yields of late-planted cotton were in the neighbourhood of 300 lbs. per acre, which very considerably reduced the general average. About 4,600 bales of 500 lbs. were produced in the district.

Experimental Work in the District.

Of the strains which had been evolved at Barberton, U.4.4, U.4.2 and U.4.4.2 had shown up best in the previous season. It was decided to put these out for observation purposes, with some Cambodia selections, on a number of different soil types in the district. This was rendered possible by the co-operation of Messrs. A. P. Rouillard, Kiernander, Bang, R. A. Rouillard and Robinson.

The soil types chosen were black soil, red loam with normal rainfall, red loam in a drier area, poor sand and alluvial loam. Very similar observations were made on each set of plots, the U.4.2 being inclined to make heavy growth and a slightly later crop than the others. U.4.4.2 was earlier and made a better crop with late planting on the black soil, while the Cambodias shed a large proportion of a big potential crop at the least climatic disturbance. One of the Cambodias, C.8.20.4.1, was distinctly less liable to this behaviour than the others.

On the thin sand an exceptionally severe attack of jassid was experienced, and the superiority in jassid resistance of the Cambodia selections over the U.4 strains was rather marked.

Two variety tests and five spacing trials were laid out in the district. One variety test was carried out by Mr. Moerdyk, officer in charge of

the Government Irrigation Experiment Station at Magut, and one by Mr. Robinson at N'kwaleni in the south of Natal. Of the spacing trials, four were failures as a result of an insufficiently good stand being obtained for experimental purposes. The results of the fifth spacing trial and of the variety trials will be discussed with the results of similar experiments carried out on the Station.

Experimental Work at the Station.

Cotton Variety Tests.

1. U.4 *re-selections.*—From their behaviour in comparison with that of U.4 Mixed Bulk and its re-selections in the previous season, it was decided that the Z.1 strains and A.12 could safely be omitted from variety tests. Of the re-selections from U.4 Mixed Bulk, U.4.2 and U.4.4 were included in a test with Mixed Bulk, as these had shown a definite increase in yield in the small variety test carried out in the season 1928/29. U.4.4.2 was grown on the Station for the first time, and as it has certain characteristics in which it differs considerably from the other re-selections and had turned out so well at Barberton in the previous season, it was included in the Variety Test.

The layout of the trial was modified in accordance with the results obtained at Barberton last season from experiments on technique in connection with these trials. Ninety foot rows were standard, with four rows to a plot for a comparison on the half-drill strip method. Adjacent pairs of rows were used for comparison of yields, and as ample seed of U.4.4 was available, this was used for the control plots. The comparisons are made on the basis of six replications of each variety.

TABLE I.

Yields in Variety Trial of U.4 Re-selections.

Variety.	*Yield in lbs. seed cotton per acre.*	$\frac{\bar{d}}{\epsilon_d}$	*% Increase over U.4 Mixed Bulk.*
U.4 Mixed Bulk	1,076	3·85	—
U.4.4—Magut Seed	1,132	Control	5·2 %
U.4.4.2	1,144	Not significant	6·3 %
U.4.4—Barberton Re-selection ...	1,149	" "	6·7 %
U.4.2	1,176	1·18	9·3 %

All the re-selections thus show an increase in yield over the U.4 Mixed Bulk. No appreciable improvement seems to have been made in the bulk selection taken from U.4.4 the previous season at Barberton. The amounts of each variety harvested at the various picking dates, expressed as percentages of the total crop, show up well the earliness of U.4.4.2 and the comparative lateness of U.4.2.

TABLE II.

PERCENTAGES OF TOTAL CROP PICKED AT THE VARIOUS REAPING DATES.

Variety.	*Reaping Dates.*							
	4/4	11/4	18/4	28/4	16/5	23/5	4/6	12/7
U.4 Mixed Bulk	31·3	15·2	11·9	10·6	18·8	6·8	2·2	3·2
U.4.4.Magut	31·5	15·5	11·0	10·4	19·6	5·0	3·1	3·9
U.4.4.2	33·8	18·8	12·0	9·6	16·6	3·7	2·4	3·1
U.4.4.Barberton	28·8	17·5	10·4	9·1	20·8	5·4	3·7	4·3
U.4.2	25·4	16·9	10·3	10·3	20·2	6·8	4·8	5·3

It is probable that in a season less favourable to an early variety of cotton, U.4.2 would have showed to greater advantage.

2. *Cambodia Selections.*—Five of the best of the Cambodia selections were put out in a test with U.4.4. The layout of the trial was similar to that adopted in the test of U.4 re-selections, which has been outlined. U.4.4 was used as control.

TABLE III.

YIELDS IN VARIETY TRIAL OF CAMBODIA SELECTIONS.

Variety.	*Yield, lbs. per acre seed cotton.*	$\frac{\bar{d}}{\epsilon_d}$
U.4.4	1,064	*Control*
C.8.20.4.2	950	3·85
C.8.20.4.1	941	2·84
C.T.C. 15/4	929	2·11
C.8.7.7.5	892	4·40
C.8.7.7.4	784	6·03

The yield of all the Cambodia selections is significantly below that of U.4.4 and during the coming season work with these selections will be discontinued.

3. *Variety Tests in the District.*—Reference has already been made to two other tests of the newer strains which were carried out in the district. An experiment on a similar scale to that on the Station was laid out by Mr. Moerdyk, under irrigation. It was unfortunate that his cotton was infested with stainer (*Dysdercus*) very early in the season, as some extraordinary yields would otherwise have been obtained. As it was, a great deal of the crop was lost, but sufficient was picked to show the superiority of the U.4 re-selections over U.4 Mixed Bulk, the Cambodia selections and A.12. A.12 previously was thought to have great possibilities as a strain for use with irrigation.

A second variety test away from the Station, which included the three selections from U.4 and two of the Cambodias, was carried out by Mr. G. Robinson, who is farming in the N'kwaleni Valley. The experiment was laid out on a very much simpler scale than those

which have already been described, and a certain loss of stand occurred through irregular germination. One of the Cambodias, C.8.7.7.4, showed up very well, and it seemed that physiological shedding had not interfered with the crop to anything like the same extent as at Magut. The figures show that the size of plots and the number of replications were not sufficient, and it is felt that work with the newer strains in a district so far from headquarters will be equally useful in future if it is restricted to observation plots, with no attempt at an accurate yield trial.

Multiplication Blocks.

In order that seed should be available, if necessary, for a first general multiplication of any of the newer strains, small multiplication areas of each of the strains tested were hand-planted on the Station. It was decided, however, at the end of the season, that no definite multiplication plan on a large scale should be embarked upon in season 1930/31.

Cotton Spacing Trials.

It was the intention at the beginning of the season to have a number of accurate spacing experiments in the area. All through the district there are differences of varying degree in the general conditions affecting yield, and it was felt that a more accurate idea of the best spacing to adopt would be gained from an analysis of yields and of conditions leading to these yields in a number of instances, rather than from the results obtained on one soil type and with one set of climatic conditions.

Four trials were planned away from the Station, but only in one case was a sufficiently good stand obtained for experimental use. The seed was planted as fast as it would run through the ordinary 2-row cotton planter, to be thinned later and laid out in $\frac{1}{40}$ acre plots with the necessary replications of the various spacings. It is not generally advisable to plant before the middle of October, and it was unfortunate that germinating conditions were bad at the time when the bulk of the planting in the district is usually carried out.

Three spacings were used in the trials—12 inches, 24 inches and 36 inches in the row, rows in each case being 3 feet 6 inches apart. U.4.4 was used, as it was considered one of the types which may eventually replace U.4 Mixed Bulk. The experiments were desig ed for comparison on the half-drill strip method, the 24-inch spacing being used as control with twelve comparisons. The plots were six rows each, 90 feet long, one outside row of each plot being discarded at picking to allow for the root interference of any spacing with the ones adjacent to it.

TABLE IV.

YIELDS IN SPACING TRIAL, EXPERIMENT STATION.

Spacing.	*Yield in lbs. seed cotton per acre.*	$\frac{\bar{d}}{d}$
12 inches...	862	·96
24 inches...	816	Control
36 inches...	780	·87

TABLE V.

PERCENTAGES OF TOTAL CROP PICKED ON EACH PICKING DATE.

Spacing.	*Picking Date.*					
	2/4	16/4	23/4	7/5	20/5	4/6
12 inches	43·6	33·8	6·8	10·6	4·9	·3
14 inches	32·5	35·6	9·9	12·5	9·2	·3
36 inches	23·8	33·6	11·8	15·6	10·9	5·2

TABLE VI.

YIELDS IN SPACING TRIAL, BURGERSRUST.

Spacing.	*Yield in lbs. per acre seed cotton.*	$\frac{\bar{d}}{d}$
12 inches...	1,125	Not significant
24 inches...	1,114	Control
36 inches...	961	2·58

From Tables IV and VI it will be seen that the close spacings have come out on top, but statistically the differences are not significant. Table V shows the extremely sudden finish to the crop early in June. The rains at the end of February brought on a fresh development of squares after the dry spell in that month, and the bulk of these were shed after the rains in mid-March. The response of the wider spacings to the February rains was greater than that of the 12-inch spacing, and it is probable that had there been less upsetting conditions in March the positions of the spacings would have been reversed. It will be seen from Table V that the 12-inch spacing gained its lead in the first picking, and showed less ability to produce later bolls under the conditions described than the wider spacings.

From an experiment with only three spacings it is difficult to say between which limits the optimum spacing is likely to occur, when the same sequence is found both in spacing distances and yields. Further spacing trials will be carried out with a larger number of different spacings for comparison.

Time of Thinning in Relation to Rain.

The experiment which has been carried out previously to determine the optimum height of seedling cotton for thinning was not repeated in the season under review, as it is felt that so long as the beetle (*Syagrus rugifrons* Baly) continues to take such a large proportion of young plants, the operation of thinning will have to be left until sufficient growth has been made for the plants to withstand any further beetle attack that is likely to occur.

For this reason, and because of other losses which may take place, thinning is often left until plants are a foot in height, and then is carried out when the stand is showing signs of distress from water shortage. It thus frequently happens that thinning is effected in the middle of a period of drought.

An experiment was laid out to determine how far yield is affected by thinning during a dry period. The operation of thinning necessarily interferes with the root system of the plants which are left, and it is felt that these are able to make a quicker recovery when the soil is moist. The experiment was arranged on the same lines as the Spacing trial which has been described. The control plots were thinned on December 16th, after a very dry hot spell of eight days. It was fortunate that 0·45 inch of rain fell on the following day. One set of plots was thinned on December 19th, which operation was followed by 0·62 inch of rain. The second and third sets were thinned on December 21st and 23rd.

During the time between the thinning of the first and last plots, practically no growth was made, so that the only factor of importance likely to affect growth was that which it was desired to test.

TABLE VII.

Time of Thinning.	*Yield, lbs. seed cotton per acre.*	$\frac{\bar{d}}{d}$
December 16th, before rain	690	Control
December 19th, after 0·45 inch rain	756	·58
December 21st, after a further 0·62 inch rain ...	761	2·26
December 23rd	763	·93

The result shown in Table VII, although not showing a statistically definite increase in crop resulting from thinning after rain, is sufficiently suggestive to warrant a further test with a larger number of replications in the season 1930/31.

TIME OF PLANTING.

Observation plots were planted on October 12th, October 25th, November 7th and December 21st. The first three dates cover the normal planting season. Every year a certain acreage in the district is planted very late in the season, and the fourth set of plots was put in for observation on the behaviour of late-planted cotton.

The first two plantings behaved in a normal fashion, a good stand being obtained without difficulty. Fruit was set early and general growth ceased at the end of March. Early-planted cotton does not seem to make as large a bush as that planted later in the season. Sufficient fruit is set to retard vegetative development before the really good growing weather in January.

Difficulty was experienced in getting a regular stand with the November 7th planting, but the final yield was practically identical with that of the earlier plantings. Rather larger bushes were formed.

Stainer damage was not measured, as it was nowhere bad.

TABLE VIII.

YIELDS FROM TIME-OF-PLANTING PLOTS.

Planting Date.	*Yield, in lbs. seed cotton per acre.*
October 12th	1,075
October 25th	1,104
November 7th	1,046
December 21st	398

COTTON VARIETIES OBSERVATION PLOTS.

Twenty-one of the better selections taken from U.4. by Mr. Parnell were grown on the Station for observations to be used in conjunction with observations made elsewhere. Unfortunately, an irregular piece of ground was chosen for the plots, and this, combined with a poor germination and beetle attack, made them rather hopeless for observations on plant habit, etc. Notes were taken on jassid resistance, which would not be affected to any extent by the factors mentioned.

Half-acre plots of Zululand Hybrid, A.12, and Z.1–9, were grown for demonstration purposes beside a small block of U.4.2. The Zululand Hybrid was very badly damaged by jassid, while it was apparent that in no case was the crop anything like that carried on the U.4.4. Small plots of these varieties will be grown every year for a standard of comparison with the new selections from U.4.

Rotation Work.

Cotton.—The outstanding feature of the rotation work was the great importance of adopting some form of rotation as a means of control of the beetle. One block on the Station has been given over permanently to cotton, and it was only on this block that the beetle became a serious menace. Great difficulty was experienced in establishing a stand, parts of the block being re-planted twice, and, with the exception of a block planted in December, the final yield was the lowest on the Station. This was not due to the effect of the previous crop of cotton, as is shown by some crops which have been reaped in the district on lands which are still beetle-free, but which have borne cotton for ten successive years. Plants which had escaped beetle damage were quite normal, but whole patches had been eaten right off and the bulk of the remaining plants were so late that they were unable to set a crop.

The best yield of bulk-planted cotton was obtained from a field which had been divided between sunflowers, sunnhemp (for seed), Soya beans and Tepary beans. Separate yields were not taken, but there was no apparent difference between the cotton on any one quarter and that on another, apart from a general grade which is thought to be due to soil variation.

Groundnuts and maize both make satisfactory rotation crops for cotton, over 1,000 lbs. seed cotton per acre being reaped from a block which gave a heavy crop of maize the season previously.

Buckwheat as a green manure crop is of uncertain value. The cotton grown on a block into which a crop of buckwheat had been ploughed in the season 1928–29, seemed to behave in a manner precisely similar to cotton on land fallowed previously. It was not able to make the same rapid growth in December and January that characterised cotton on lands which had had different treatment in the season 1928/29. In such a season as was experienced (an exceptionally early one with a quick finish) cotton which did not make a good start was not able to make up for it later in the year.

Maize.—Four acres were planted to Wisconsin White Dent at the end of January. Rains at the time when the "silk" was showing did not materialise, and only very small cobs were formed, with a resulting poor crop.

Sunflower.—A block of striped sunflower gave a yield of 740 lbs. per acre. This crop was grown on a very thin soil overlying shale, and very quickly showed signs of water shortage in the dry spells which were experienced, and in so far as a very much heavier crop could be expected on a deeper soil, the yield is misleading.

The block was planted December 9th at the seed rate of 6 lbs. per acre in rows 3 feet 6 inches apart, and later was thinned to 2 feet in the row. If it could be made to fit in with cotton planting, an earlier planting date seems advisable. Some form of mechanical thresher for dealing with the heads would cut down the cost of handling the crop very considerably.

Groundnuts.—A block was planted on December 9th to Virginia Bunch groundnuts for a further test of ridging *versus* flat cultivation. The flat cultivation again gave the higher yield, but yields were in neither case equal to those of the previous season. The crop had to be removed before a proportion of the nuts was fully developed, as the heavy rains in March caused sprouting of the matured crop. In future work on groundnuts, a slightly later planting will be made. A test of five of the most promising varieties was laid out, but a very irregular stand was obtained and the test was abandoned.

Kaffir Corn.—Difficulty has always been experienced on the Station in obtaining a crop of Kaffir corn owing to the activity of the stalk-borer (*Busseola fusca* Fuller). It had been noticed that heavy infestation of this pest does not normally occur until December, and as conditions for very early planting were favourable, two blocks were planted at the end of September to Kaffir corn. Two varieties were sown, a selection from Hegari made on the Station and a Dwarf Red variety, the seed of which was obtained locally.

The early planting succeeded in its purpose of defeating the borer, but early in December a very severe attack of aphis and rust spoiled a good potential crop on the Dwarf Red. The Hegari selection seemed much more rust resistant, and a fair crop was reaped in January.

Tepary Beans.—Various planting dates were used in experimental work on this crop, but in no case was a yield obtained equal to that of the previous season.

Great interest was shown in the crop locally, as it seemed the best rotation crop that had been tried so far. About 4,600 lbs. were planted in the district.

The chief drawbacks to the use of Tepary beans on a large scale seem to be the need for harvesting within very short time limits, and the liability of the crop to be very badly damaged should a rain fall when the beans are ripe. It is felt that the chance of damage from rain and the resulting wash in the lands will be reduced by interplanting with a heavier growing crop such as maize or sunflower, and experiments in this direction will be carried out in season 1930/31. The best time for planting is December and January, and the spacing of 2 feet 6 inches by about 6 inches is satisfactory. A certain amount of damage resulted

from a leaf curl disease. About 5% of plants under non-irrigated conditions were affected. Plants begin to show the disease at flowering time 6–8 weeks after planting, and diseased plants are unable to set fruit.

Soya Beans. –The variety known as Southern, which showed the best behaviour with regard to shattering in the season previous to that now under review, was grown on the Station on a field scale. Soya beans have disadvantages in large scale use rather similar to Tepary beans, but are far less liable to damage from rain when the crop is ripe. Planting should be carried out in November, and a spacing similar to that of Tepary beans is satisfactory. A crop of 1,050 lbs. per acre was reaped. Previous cropping or the addition of superphosphate did not have any effect on the yield. After fallowing there was much slower growth in the early stages.

Buckwheat.—A small area was planted to buckwheat in order to enable observations to be continued on the effect of this used as a green manure on cotton the following year.

Pests and Diseases.

Sudan Bollworm (*Diparopsis castenea* Hamps).—At no time during the season did an attack of Sudan bollworm of the severity of any experienced in previous seasons occur. From November the worm was present to the end of the season in May, but never in any numbers. One flare was in use for practically the whole period, but the catches were quite insignificant.

American Bollworm (*Chloridea obsoleta* Fabr.).—With the decrease in Sudan bollworm the damage caused by the American bollworm seems to increase proportionately. As has been reported in notes on its habits, its attacks are localised, but the number of affected areas during the season showed a large increase over those of previous seasons. The first severe attack appeared on some ratoon cotton early in November, and from this time until the end of April it was seen in areas of up to 60 acres all through the district.

There seems at present to be no economical means of control within the reach of the farmer. Where the bollworm appears practically every boll and square is taken. It was fortunate that so much of the area was planted to U.4, as in instances where the attack had not occurred too late in the season, an entirely fresh crop was set and brought to maturity.

A certain area in the Magut district is to be ratooned in the season 1930/31, and a close watch will be kept for the reappearance of the bollworm, when steps may be taken to destroy the first brood of worms by feeding off the young growth to cattle.

Beetle (*Syagrus rugifrons* Baly).—At present the beetle is the chief pest of cotton in the district. This has come about simply through the practice, which is still quite general, of planting cotton year after year in the same lands. It is not fully realised how important a factor in obtaining a high yield per acre is the regularity of stand, and it is thought that the damage done by beetle, apart from causing a total loss of stand, as frequently happens, is heavy even in those lands where it is thought that beetle damage is negligible.

Observations on the Station and in the district have led to the following conclusions :—

A definite method of control is to adopt some form of rotation, either by planting an alternative crop or by allowing the land to go to grass. On badly infested lands this would have to be done every alternate year, the greatest care being taken that no " volunteer " cotton is allowed to remain to form a centre of infection. A strip of about 5 yards in width of ratoon cotton should be left round the infested lands to hold the beetle from migrating to lands which are to be planted to cotton the following season. On the Station cotton was planted on one block following a crop of maize in the previous season ; one end of this block was adjacent to an old cotton land planted with beans this season. Every plant was killed when in the seedling stage for a distance of three yards, but the attack came to an abrupt finish at this point, showing quite definitely that beetle was not present, and that the attack was progressive from the old cotton land.

The five yard strip might be made a more certain break by planting gaps in the stand with cotton in March, or when conditions are suitable.

When the beetle appears in numbers the trap rows may be heavily dusted with calcium arsenate, and hoed out when the plant cotton has reached a stage where beetle can no longer kill the plants ; any further migration which may take place from the old cotton lands will then cause only minor damage.

It was reported by Mr. Butler of the Ntambanana Settlement, that he was able to control the beetle by taking advantage of its habit of hiding at the base of the seedling plants and its supposed inability to rise through more than a few inches of soil. He used Fowler cultivators, which have a slight ridging effect, and by means of frequent cultivation so covered the beetles that they were not able to rise and continue their damage. The value of this as a control measure will be further tested in the coming season on the Station.

Infestation of beetle-free cotton lands takes place in January. The actual migration has not been observed, but blocks on the Station which until this time had been free from beetle, began to show signs of

damage. In order to reduce the numbers of beetle on the Station, a change is to be made in the general scheme. It has been the plan hitherto to arrange the blocks so that only in the case of the "continuous cotton" block is cotton grown on the same land for more than a year, but no definite arrangement of the blocks was made. Usually about half the area was under cotton. To reduce the number of ratoon traps and the amount of dusting required, it is proposed to divide the Station into two portions, on one of which all the cotton on the Station will be grown while still retaining the existing blocks for rotation crops. There will thus be only one zone of ratoon trap cotton to deal with in place of small traps in various parts of the Station as before. It is thought that this plan could be very easily adopted on a larger scale on a number of farms in the district.

Stainer (*Dysdercus*).—Damage done by stainer was only of very minor importance, the grader's report on all the lint, with the exception of a small quantity picked in June, being good colour. Stainer appeared in April, but not in large numbers, and the good report on the lint may be put down to the earliness and sudden finish of the season.

Improvements at the Station.

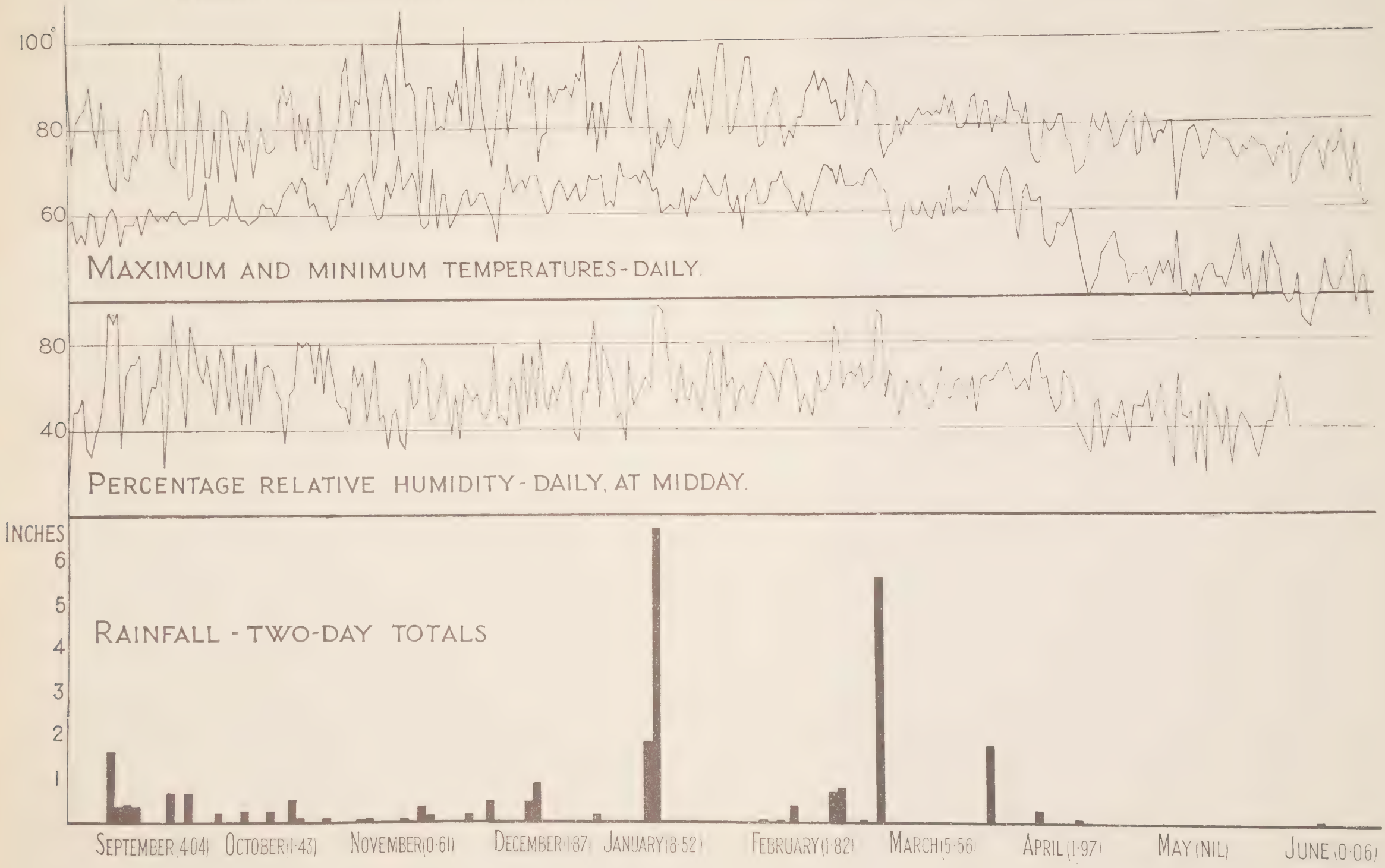
The Station, which was formerly on the lands of Candover Estates, Ltd., has now become the property of the Union Government. 400 acres of land, of which about 150 acres are arable, have been reserved for the use of the Corporation, together with the site with the asistant's quarters and the house on Magut Hill which is occupied by the writer.

Until the liquidation of Candover Estates a certain amount of work for the Station was carried out by them in the way of transport and loan of implements. Implements have been purchased during the season to make the Station entirely independent on outside help.

Mr. Arthur Foster and Sir James Currie visited the Station in May. It was decided that more arable land should be brought into cultivation, and for this purpose further oxen and implements were purchased and the storage shed enlarged.

During the year certain improvements have been made to the water storage facilities at the dwellings, and for the oxen.

Magut Experiment Station – Climatic Conditions 1929-1930



SWAZILAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS FOR THE SEASON 1929-1930.

BY

D. MACDONALD.

SUMMARY.

Season.—Early rains enabled the whole of the cotton crop in the territory to be planted early, under very good conditions. In North Swaziland more than sufficient rain for the requirements of the crop fell throughout the season, continuing until April, but parts of South Swaziland experienced periods of severe drought.

Cotton Crop.—Apart from a small area of ratooned cotton under Z strains, the whole of the area was planted with U.4. Damage by American bollworm (*Chloridea obsoleta*) was general over the whole of Swaziland, the earliest planted cotton being most severely attacked. In North Swaziland an increase of 76% over the previous season is shown in the ginnery returns of the amount of lint exported.

Experimental Work.—The cotton experiments on the Matapa Station, Bremersdorp, were practically all destroyed by hail, and no yield figures were obtainable.

The variety tests on the Ingwavuma Station showed one of the re-selections, U.4/4, to be significantly better than the original U.4 bulk, the yields being 596 lbs. and 479 lbs. of lint per acre respectively. The same strain in another test of ten re-selections on the above Station, again gave the highest yield of lint per acre. On account of the varying ginning percentages of the different selections tested, all the yield figures are worked out in terms of lint per acre.

The Spacing and Manurial experiments planted were rendered useless by bollworm damage.

Rotation Crops.—The results of the different rotation crops tried confirmed the previous season's results. Two varieties of groundnuts did well on both Stations for the second year in succession, while Sunflowers again showed themselves a crop suited to the district.

In fertilised and unfertilised plots of different beans on the Ingwavuma Station only Tepary Bean (*Phaseolus acutifolius*) gave a higher yield on the fertilised plots.

Introduction.

The successful multiplication of U.4 seed reported in the 1928-29 Report provided sufficient seed for most of the requirements of the Territory. Purchase of the surplus seed from the Barberton District was arranged and all applications for seed were filled.

Apart from the small area of ratooned cotton under Z.1 strains, practically the whole of the season's crop came from U.4 strains. The results obtained are reflected in the figures supplied by the Bremersdorp Ginnery. For the season under review the ginnery returns show a nett increase of 76% in the weight of lint exported, over those of the previous season. The average ginning percentage of the seed-cotton dealt with by the above ginnery last season was 33·0 as compared with 29·24 for the previous season.

The acreage under cotton in the district showed a slight increase over the previous season. Although the increased acreage was partly responsible for the increased production of lint, most of the credit for the increase may be attributed to the strain. Damage done by severe attacks of American bollworm throughout the season would more than counteract any increased production due to acreage, if the old strains of cotton had not been replaced by U.4.

Development of Stations.

During the past three seasons all the cultural work on the Bremersdorp Station land was done by oxen and implements, hired from Mr. P. J. Lewis, the owner of the farm on which the Station is situated. This arrangement has not been entirely satisfactory and the necessary oxen and implements for all cultivation work have been purchased during the past season. Satisfactory arrangements have been made with Mr. P. J. Lewis for the grazing of oxen in a paddock alongside the Station. The fencing of this paddock has been completed.

In the past practically all the cotton in Swaziland was grown under dry-land conditions. The low veld, however, offers irrigation possibilities, and Messrs. Cotton Plantations Ltd., the largest cotton growers in Swaziland, have installed a pumping plant in the Ingwavuma River, with a view to irrigating part of the crop this coming season. As little is known about the behaviour of the U.4 selections made at Barberton, when grown on irrigated land, it was felt that useful work

could be done testing out the behaviour of the various types when grown under irrigation. Messrs. Cotton Plantations Ltd. kindly offered to supply free, the necessary land, water and labour, for work of this nature on both cotton and rotation crops to be carried out under the supervision of the Corporation. With the assistance of Mr. J. V. Lochrie an area of land about 11 acres in extent was chosen and will be used for the preliminary work to be carried out during the course of the coming season.

Season and Climatic Conditions.

Middle Veld Area.—The total rainfall recorded on the Bremersdorp Station during the past season from September to July was 33·36 inches. The season opened under very favourable conditions ; good rains beginning in early September facilitated the early preparation of the land for planting. Good rains continued throughout the next month, and little difficulty was experienced in obtaining good stands at planting time.

Planting was begun in the latter part of September, but the main area was planted from October 10th onwards, planting being completed by November 10th.

At no part of the season did the crop suffer from lack of rain in this district, ample rain continuing to fall until late April. Growth during November and December was very slow ; heavy rains, coupled with low temperatures during these months gave a severe set-back to the crop. Throughout this period the lands were much too wet to permit of any proper cleaning or cultivation, and in many cases weeds gained the upper hand and further retarded growth of the crop.

A very severe hailstorm on December 6th followed by heavy rain on the three following days did considerable damage to young crops in the district. The storm was particularly severe over the Experiment Station, and completely destroyed the cotton variety tests and all other experiments planted at that date. The heavy rains following immediately after the hail prevented the lands being prepared for replanting until it was too late to replant with cotton.

From January onwards warmer conditions prevailed and a comparatively dry spell in the end of January enabled farmers to clean the land thoroughly for the first time during the season. Warmer, drier conditions, coupled with freedom from weed competition, stimulated growth, and a rapid setting of the crop took place. American bollworm damage was general throughout the area from December onwards, and in some cases the attack was so severe that

it was only the extraordinarily prolific fruiting habit and powers of recovery of the U.4 strain that enabled any crop to be left. The attack was most severely felt in the earlier planted cotton, most of the first setting of fruit being completely destroyed.

The heavy rain continuing until late April ensured an ample supply of moisture for maturing the late-set top crop, but frost in early winter destroyed most of this. Rotation crops like Sunnhemp and Sunflowers suffered from heavy winds in mid-June causing shattering of seed.

Low Veld—Ingwavuma Sub-Station.—The total rainfall recorded in the Ingwavuma Sub-Station amounted to 22·52 inches for the season, as compared with 20·86 inches for the previous season. Although the total is not very high the distribution of the rain was reasonably good and some very high yields were obtained on the Station. Good rains beginning in early September and continuing during October were general throughout the low veld, giving ideal planting conditions, and little trouble was experienced in obtaining good stands.

Most of the soils in this area can be winter ploughed and require very little working down when the rains come to give a good seed bed. This permitted a fair proportion of the crop to be planted during September and planting was completed by mid-November or earlier.

From mid-November onwards rainfall conditions in the low veld varied considerably. The rainfall chart (p 113) shows a reasonably distributed rainfall until the end of March, but unfortunately this cannot be taken as a rigid criterion of low veld conditions. Part of the Ingwavuma district within eight miles of the Station recorded no effective rainfall from mid-November until mid-January. A good rain in mid-January re-started growth, but as no following rain came until well on in March most of the plants were undersized and stunted in growth throughout the season.

The scanty rainfall plus severe bollworm damage lowered yields throughout the area.

In conclusion it may be stated that, despite adverse climatic conditions and pest damage, if the final yields per acre be taken as the standard of judgment, Swaziland as a whole has enjoyed the best season since the Corporation began work in the Territory.

Cotton Experiments.

Matapa Station, Bremersdorp.

A variety test of three big bulk selections from U.4, viz., U.4/2, U.4/1 and U.4/4/2 and U.4 Bulk was planted on the half-strip method, using 4/4 as a standard. A further test of ten U.4 small bulk

re-selections was planted in randomized blocks according to the method recommended by Fisher.

These experiments along with the spacing tests and fetilizer trials conducted on the above Station were completely destroyed by the hail storm on December 6th. Fortunately most of the tests were duplicated on the Ingwavuma Station.

Variety Trials.

Ingwavuma Station.

A variety test of three big bulk selections from U.4 bulk, viz., U.4/2, U.4/4 and U.4/4/2 together with U.4 Bulk was planted on the half-strip method. In the previous season U.4/4 had appeared to be rather better than the other strains, judging from its behaviour in observation plots, and was accordingly used as the standard of comparison. Six repetitions of four-row plots, ninety feet in length, were used, giving twelve comparisons of two-row strips with the standard, for each variety.

The test was planted on October 25th and a uniformly good stand was obtained for all varieties. Growth throughout the season was moderate for all strains and the plants never attained any great size. No serious set-back was experienced during the season and the slight checks caused by dry spells were just sufficient to make the varieties fruit well.

As the ginning percentages of all the U.4 selections vary appreciably, the results have been worked out in terms of lint instead of seed cotton per acre. The results are given below in Table I and the analysis of lint characters, etc., in Table II :—

TABLE I.

Variety.	*Yield per acre seed cotton. lbs.*	*Yield per acre lint. lbs.*	*D=Mean Difference from Standard U.4/4, ozs. lint.*	*E= Standard Error of Mean Difference.*	*Ratio* $\frac{D}{E}$	*P.*
U.4/4/2 ...	1,602	594	1·3	2·1	0·62	0·5
U.4/4 ...	1,639*	596	—	—	—	—
U.4/2 ...	1,622	550	11·3	3·6	3·14	·01
Bulk ...	1,430	479	28·5	5·5	5·18	·01

*Average yield per acre against all varieties.

P=Probability integral.

TABLE II.

Variety.	*Boll weight grms.*	*Weight of 100 seeds. grms.*	*Ginning %*	*Lint length. mms.*
U.4/4/2	4·6	9·5	37·1	31·3
U.4/4...	5·0	10·1	36·4	31·4
U.4/2...	4·3	9·2	33·9	29·9
Bulk	4·6	9·6	33·5	30·5

Examination of the results show U.4/4 to be significantly better than Bulk, and U.4/2, the difference between the strains and U.4/4 being respectively 5·18 and 3·14 times the standard error. There is no significant difference between U.4/4 and U.4 4 2 as judged by the ratio of the mean difference to the Standard Error. In terms of seed cotton U.4/4/2 gave the lowest yield per acre, apart from Bulk, but its high ginning percentage brings it up to second place in yield of lint per acre. This strain is a small, early, uniformly good fruiting type, which sets its crop rapidly, but is not quite so liable to resume fruiting after a serious check as some of the stronger growing varieties. U.4 4 is also a small uniform fruiting type, rather sturdier and not so early as U.4/4/2, but carrying on fruiting for a longer period and having rather better powers of recovery from set-backs.

The conditions during the past year at Ingwavuma, *i.e.*, scanty rainfall finishing up early in the season, combined with an early winter, favoured the U.4/4/2 and U.4 4 types as compared with the U.4 2 strains. This is a late, much stronger growing, and more vegetative type than the other two and requires a rather longer season to do itself justice. Under different conditions there is little doubt from the results of observation plots of the three strains scattered throughout the territory that the difference in yield between 4 2 and 4 4 2 would be more in favour of 4/2. The actual yield of 4 2 in the test in terms of seed cotton is considerably higher than that of 4 4 2, but its low ginning percentage makes its yield in terms of lint per acre lower.

Ten Strain Variety Test.—Eight small bulks made from the best of the single plant progeny rows grown the previous season were put in a test along with the two strains U.4/4 and U.4/4/2. The eight bulks were labelled C.15, C.39, H.7, H.76, H.77, L.17, L.18 and Z.9. The experiment was laid out in randomized blocks according to the method recommended by Fisher. Two-row plots 90 feet long, and a standard spacing of 3 feet 6 inches between rows with plants 2 feet apart in the rows, were used, repeated six times for each variety.

The blocks were planted on October 29th and picking began on March 24th, being continued at weekly intervals until May 12th. A final picking was taken of all clean saleable cotton left on June 5th and included in the total yields per acre.

The strains in the test covered a range of early, medium and late types. Differences in growth and earliness were not so marked on account of the light rainfall and short season as the differences exhibited by the same varieties when grown in observation plots in areas of heavier rainfall.

None of the varieties grew very big, but the fruiting as judged on the final yield figures was excellent throughout all the varieties.

Jassid infestation on the Station was so light that no differences in jassid resistance could be noted in the strains in the test.

The significance of the yield differences between varieties have been worked out by Fisher's Analysis of Variance method. The ginning percentages of the strains in the list varied so much that all the results were worked out in terms of lint per acre.

The results are given below :—

Variety.	U.4/4/2.	U.4/4.	*H.7.*	*C.39.*	*C.15.*	*H.76*	*Z.9*	*L.17*	*H.77*	*L.18*
Yield in lbs. per acre Seed Cotton.	1,214	1,226	1,269	1,218	1,206	1,138	1,172	1,129	1,146	1,087
Yield in lbs. per acre Lint.	450	446	439	428	412	402	401	386	369	353

Standard Error of Difference between two varieties 22·03.

DIFFERENCES BETWEEN VARIETIES FOR VARIOUS VALUES OF P.

P.	·01	·02	·05	·1
Difference in lbs. per acre	56·8	51·3	43·2	36·1

The lint characters etc., for the above varieties are as follows :—

Strain.	*Boll weight grms.*	*Weight of 100 seeds grms.*	*Ginning %.*	*Lint length mms.*
U.4/4/2	4·6	9.5	37·1	31·3
U.4/4	5·0	10·1	36·4	31·4
C.15	4·4	9·4	34·2	29·5
C.39	4·5	9·5	35·2	30·4
H.7	4·5	10·9	34·6	30·0
H.76	4·4	9·5	35·3	31·5
H.77	4·6	10·3	32·2	30·9
L.17	4·7	10·0	34·2	30·9
L.18	4·9	10·1	32·5	31·5
Z.9	4·7	9·6	34·2	29·6

The early strains have again come out on top, both U.4/4 and U.4/4 2 being significantly better than the last five lots in the table. The only late variety to do well was C.39. This strain has been very disappointing elsewhere, and although promising well for most of the season failed to ripen its crop, apart from the above instance.

Observation Plots.

With the kind co-operation of farmers a series of six sets of approximately quarter-acre plots of the following strains were grown: -U.4/2, U.4/4, U.4/4/2, C.15, C.39, H.7, H.77, L.18 and Z.9. All these strains were included in the Variety Trials and it was with a view to further testing them under as a wide a range of soil and climatic conditions as possible that they were put out. As the size and percentage stand in the plots varied considerably no yield figures are given, and the conclusions drawn are from observations only.

No one strain was outstandingly superior to the others under all the conditions under which the strains were grown, and in many cases the strains which finished up best were not those which came out with the highest yield in the Variety Trial. H.7 and C.39. 3rd and 4th respectively as judged from the Variety Trials results, did not take a high place in what may be called the order of merit in the Observation Plots ; where rainfall conditions were better, C.39 in particular was very disappointing. For the greater part of the season it was outstandingly good in fruiting, although very late, but in no place except on the Ingwavuma Station did it ripen its crop.

The other two late types U.4/2 and H.77 were consistently good everywhere they were grown. Both are tall, strong growing, late types and showed very good jassid resistance.

Neither of the two medium types Z.9 or L.18 was particularly good, and although L.18 had very good lint the strain was not sufficiently resistant to jassid to warrant its being carried on. It was also a comparatively poor cropper on both the variety test and all the observation plots.

With regard to the early types, U.4/4/2 did not show up as well as the late types where the rainfall was ample and the season long. U.4/4 is a better cropper and slightly tougher than U.4/4/2, but as the bulk stands at present it requires further re-selection to make it uniformly jassid resistant. At the present stage the bulk contains some excellent plants, being good fruiters and exhibiting a fairly high degree of jassid resistance, but where the strain was subjected to a severe infestation of jassid attack a number of plants showed up as being not sufficiently resistant.

The other early strain, C.15, is a small, very uniform fruiting type, producing a tougher, sturdier plant than either U.4/4/2 or U.4/4. It has never done outstandingly well in any place in which it has been grown, but on the other hand it has never done badly, and is a strain that can be relied on to produce really more than an average crop under very diverse conditions. As such it certainly merits being kept on for further selection.

By the courtesy of Messrs. Cotton Plantations Ltd., the above strains were grown on land which it was possible to irrigate. The land received approximately a two-inch watering before planting and a further four inches during the season, made up of a second watering in the end of January and a last watering of two inches in March.

All varieties made very strong growth compared with the general estate crop grown under dry land conditions, and offered a very attractive breeding ground to all the stainers in the vicinity. These insects bred up so rapidly that boll rot destroyed most of the crop and no yield data could be taken from the varieties.

With regard to lint characters, boll weights, etc., samples from each set of Observation Plots were taken and analysed. The figures given below are the mean figures for each character from the series of samples taken :—

Variety.	*Boll weight grms.*	*Ginning %*	*Weight of 100 seeds grms.*	*Lint length mms.*
U.4/2	4·9	34·9	10·0	30·6
U.4/4	5·2	36·7	10·1	31·1
U.4/4/2	4·6	36·9	9·8	30·9
C.15	5·1	35·0	10·1	30·1
C.39	4·8	35·1	9·6	30·5
H.7	4·8	35·6	10·3	30·2
H.77	5·3	33·5	10·8	31·5
Z.9	4·9	35·0	9·9	30·0
L.18	5·1	33·6	9·9	31·7

Manurial Experiment.

Manurial experiments with cotton were planted on both Stations, comparing plots receiving a dressing of 200 lbs. superphosphate per acre with unfertilized plots. The experiment on Matapa Station, Bremersdorp, was rendered useless by hail while the one on Ingwavuma Station had such a severe attack of American bollworm that practically no crop was left. The final yield figures taken from the four centre rows of eight-row plots were—

Phosphate 200 lbs. per acre dressing— 170 lbs. per acre (seed cotton)
No phosphate ... ... 149 lbs. per acre ,, ,,

Before the bollworm attack there was no difference obvious to the eye between the fertilized and unfertilized plots. The severity of the bollworm attack may be gauged from the fact that cotton adjoining the experiment, but planted slightly later, yielded 900 lbs. seed cotton per acre.

Arrangements were also made with farmers to have fertilized strips running across unfertilized fields, but in all the cases in which this was done bollworm attack caused so much damage to the crop that yield figures and observations were rendered useless.

Spacing Experiments.

A series of spacing experiments were planted on both Stations. At Bremersdorp hail rendered useless the early-planted experiments on both Bulk and U.4/4 strains. A spacing experiment using U.4 Bulk seed was planted on December 23rd in order to see if by using very close spacings, a late-planted crop could be successfully grown. The spacings adopted were 6 inches, 12 inches, 18 inches and 24 inches. The early winter prevented any of the spacings from ripening their crop, and, although the 6-inch and 12-inch spacings carried a slightly larger crop, the planting dates were too late for any spacing to produce a paying crop, even if all the crop set had matured.

At the Ingwavuma Station the spacings used were 1 foot, 2 feet and 3 feet randomized in blocks, giving six repetitions for each spacing. Eight-row plots 90 feet long with rows 3 feet 6 inches apart were used, the rows being planted in a continuous ribbon, and the plants thinned out when about 8 inches high, to the respective spacings in the row.

It was intended to take yield figures from the four centre rows of each plot, cutting out two rows on either side to obviate the effect of different spacings in adjacent plots.

A very severe attack of American bollworm during March carried off most of the crop and the final yields for 1 foot, 2 feet and 3 feet spacings were 166, 157 and 117 lbs. seed cotton per acre, respectively, with a standard error of the mean between any two spacings of 25·1 lbs. per acre.

Rotation Crops.

Sorghums.—None of the varieties of Kafiir Corn (*Sorghum vulgare*) tried on the Bremersdorp Station in past seasons ever proved successful —aphis and rust completely destroying every strain. Only one variety, a white-grained strain which had been reported on favourably on overseas markets, was tried this season, but it also succumbed to a combination of aphis and rust. On the Ingwavuma Station a range

of both red- and white-seeded varieties were tried. They were planted rather late and growth was never very vigorous. Two selections made the previous season showed up as being fairly uniform, but the highest yielding white-seeded strain requires further selection, as it is not at all uniform at present. None of the yields obtained was very high, but a number of the above strains will be carried on for further trial.

Groundnuts.—On Bremersdorp Station the varieties which had been most successful in the previous year were again grown. These were chiefly erect or bunch types, only one spreading variety being grown. The variety yields obtained followed the order of the previous season, although the individual strain yields were not so high. This is accounted for by the fact that these were planted late and the early winter prevented a large proportion of the nuts from filing properly. Two varieties, Spanish No. 10 and Small Japanese, again gave the best yields amounting to 994 lbs. and 978 lbs. unshelled nuts per acre.

At Ingwavuma a rather larger range of varieties was tried, but the results followed closely those of Bremersdorp. The Spanish variety yielded at the rate of 895 lbs. per acre, followed by Virginia Bunch, a local variety, giving 800 lbs. per acre. Another Spanish variety gave 796 lbs. per acre while the Small Japanese gave 755 lbs. unshelled nuts per acre.

The Virginia Bunch, although giving 800 lbs. per acre, did not produce such a good quality nut as the others, a fair proportion of the kernels being only partly developed. It appears to require a rather better rainfall than is necessary for the Spanish and Japanese types, to produce and mature well filled nuts.

No Rosette disease was in evidence on either Station, and provided freedom from this disease continues, some of the above varieties offer good prospect of taking a place in rotations with cotton in low veld conditions.

Beans—Bremersdorp Station.—As Speckled Sugar Beans appeared from previous seasons' trials to be suitable to local conditions, various dates of planting were tried. The presence of the C.M.R. beetle prevents planting before January and the earliest planted lots were not put in until January 10th. From the observations of the past season it appeared that yields from plots planted after the middle of February were not likely to mature a paying crop, and that the best planting dates lay between January 10th and January 30th.

Tepary Beans have never been very successful on this Station but in past years they had always been planted late in the season.

Early planted beans on the Station were destroyed by hail and a planting immediately after the hail only yielded 876 lbs. per acre while later plantings gave a negligible crop. On Mr. G. L. Wallis' Farm in the White Umbeluzi district, early planted Tepary beans produced an immense vegetative growth but set no seed.

Soya Beans.—A collection of different varieties of Soya Beans was made and small observation plots of each planted. All the varieties were so very badly damaged by small buck and game that comparative yields were useless.

Ingwavuma Station.—Five varieties of beans were tried in quadruplicated fertilized and unfertilized plots. The fertilizer used was superphosphate, applied at the rate of 300 lbs. per acre. No difference could be noted between the fertilized and unfertilized plots throughout the season and both fertilized and unfertilized plots ripened the crop at the same time. The average yields of the fertilized and unfertilized plots given below show Tepary beans as the only variety to give an increased yield on the fertilized plots.

Variety.	*Yield, lbs. per acre Unfertilized.*	*Yield, lbs. per acre Fertilized.*	*Difference lbs. per acre.*
Haricot	341	314	−27
Canadian Wonder	358	326	−32
Yellow Soy	402	402	0
Speckled Sugar	467	446	−21
Tepary	1,169	1,374	+205

Sunflowers.—Sunflowers again promised to yield a good crop on the Bremersdorp Station although planted late. Considerable damage was done prior to reaping by a very high wind which caused a lot of shattering of seed and the final yields of unshattered seed only amounted to 1,100 lbs. per acre.

On the Ingwavuma Station spacing trials of Sunflowers were laid out, but hail in June as the crop was nearly ready for reaping, rendered yield figures useless.

Sunnhemp.—Sunnhemp again gave good results on the Station when kept to seed. Seed issued to farmers at the beginning of the season proved very successful as a green manure, yielding a high weight of green matter which could be ploughed under very easily.

DAILY RAINFALLS, SEASON 1929–30.

MATAPA STATION, BREMERSDORP.

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	—	—	—	—	0·10	—	0·58	2·02	—	—
2	—	—	—	—	0·09	—	0·05	0·06	—	—
3	—	0·46	—	0·06	—	—	—	0·20	—	—
4	—	0·04	—	0·09	—	—	—	0·31	—	—
5	—	0·25	0·11	—	0·05	—	0·15	0·58	—	—
6	—	0·50	0·03	1·15	—	—	0·32	0·02	—	—
7	—	—	0·01	0·25	—	—	—	—	—	—
8	—	—	—	1·75	—	—	—	0·01	—	—
9	—	0·10	—	0·39	1·67	—	—	—	—	—
10	1·25	0·25	0·26	—	—	0·09	0·57	—	—	—
11	0·16	0·65	0·01	—	0·10	—	0·23	—	—	—
12	0·11	—	—	0·13	—	—	—	—	—	—
13	—	0·11	—	0·03	—	0·04	—	0·54	—	—
14	—	0·08	0·15	—	0·15	0·08	—	0·29	—	—
15	1·16	—	0·11	—	0·48	0·02	—	—	—	—
16	0·03	0·55	—	—	0·69	0·05	—	—	—	—
17	—	0·10	—	—	1·51	0·05	—	—	—	—
18	—	0·03	—	—	1·56	0·08	—	—	—	—
19	—	—	—	0·54	—	1·22	—	—	—	—
20	—	—	0·16	1·25	0·05	—	—	—	—	—
21	—	0·10	0·57	—	—	—	—	—	—	—
22	—	—	0·33	—	0·01	—	—	—	—	—
23	—	0·96	—	—	—	—	—	—	—	—
24	—	0·04	0·87	—	—	—	0·12	—	—	—
25	—	—	0·58	—	—	—	—	0·02	—	—
26	—	—	0·01	—	—	—	0·74	—	—	—
27	—	—	0·61	—	0·15	—	—	—	—	—
28	0·41	0·54	—	—	—	0·32	—	—	—	—
29	—	0·02	—	—	0·04	—	—	—	—	—
30	0.11	—	—	—	—	—	—	—	0·02	—
31	—	0·31	—	0·16	—	—	—	—	—	—
Total ...	3·23	5·09	3·81	5·80	6·65	1·95	2·76	4·05	0·02	—

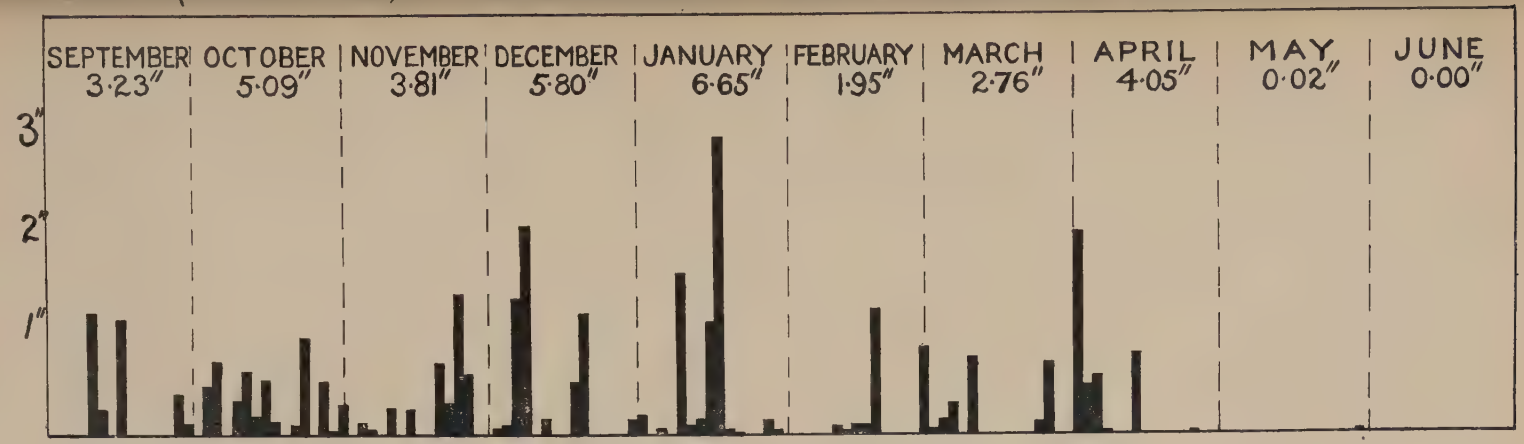
Total for the year = 33·36 inches.

DAILY RAINFALL—INGWAVUMA EXPERIMENT STATION.

	Sept.	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*June.*
1	—	0·02	—	—	0·34	—	—	—	—	—
2	—	—	—	—	0·11	0·43	0·13	0·07	—	—
3	—	0·01	—	0·06	0·10	—	0·05	—	—	—
4	—	—	—	—	0·05	—	—	—	—	—
5	—	0·15	0·19	—	—	—	0·15	—	—	—
6	—	0·37	0·01	—	—	—	0·08	—	—	—
7	—	—	—	0·16	—	—	—	—	—	—
8	—	—	—	0·55	—	—	—	—	—	—
9	—	—	—	0·31	—	—	1·97	—	—	—
10	1·22	0·15	—	—	—	—	—	—	—	0·80
11	0·75	0·08	0·28	—	—	—	—	—	—	—
12	0·90	—	—	—	—	—	—	—	—	—
13	—	0·03	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	0·29	—	—
15	—	—	—	—	—	—	0·07	0·05	—	—
16	0·47	—	—	—	1·30	—	—	—	—	—
17	0·15	0·20	—	—	1·30	0·97	—	—	—	—
18	0·22	—	—	0·03	0·48	—	0·08	—	—	—
19	—	—	—	0·61	0·90	—	0·18	—	—	—
20	—	—	—	0·50	—	—	—	—	—	—
21	—	—	—	—	—	—	0·32	—	—	—
22	0·03	—	0·28	—	—	—	—	—	—	—
23	—	0·81	0·27	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—
25	—	0·50	—	—	—	—	—	—	—	—
26	—	—	0·04	—	—	—	—	—	—	—
27	—	—	0·71	—	0·09	—	—	—	—	—
28	0·11	0·09	—	—	—	0·62	—	—	—	—
29	0·02	0·01	—	—	—	1·19	—	—	—	—
30	0·08	—	—	—	—	—	—	—	—	—
31	—	0·03	—	—	—	—	—	—	—	—
Totals ...	3·95	2·45	1·78	2·22	4·67	3·21	3·03	0·41	—	0·80

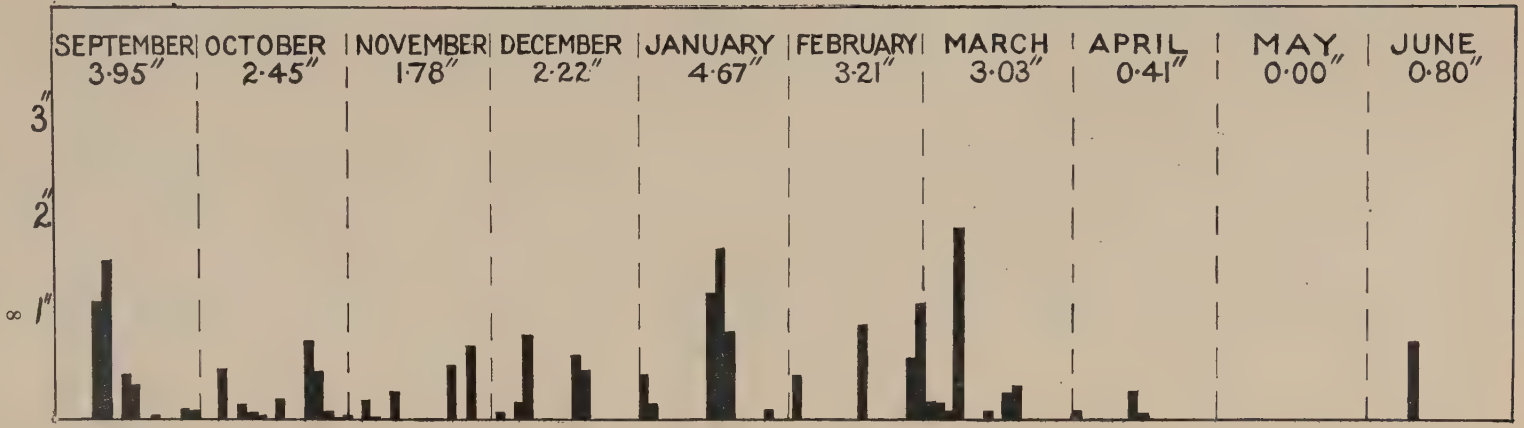
Total for year=22·52 inches.

RAINFALL (IN TWO-DAY TOTALS) AT MATAPA EXPERIMENT STATION, BREMERSDORP, SWAZILAND: SEASON 1929—30.



TOTAL 33·36″

RAINFALL (IN TWO-DAY TOTALS) AT THE INGWAVUMA EXPERIMENT STATION, SWAZILAND: SEASON 1929—30.



TOTAL 22·52″

SOUTHERN RHODESIA

REPORT ON THE WORK OF THE COTTON-BREEDING STATION, GATOOMA, FOR THE SEASON 1929-30.

INTRODUCTORY NOTE BY MAJOR G. S. CAMERON.

The accompanying report of the past year's work at the Government Cotton Breeding Station, Gatooma, is considerably longer than any of the previous reports. This is unavoidable on account of the expansion which naturally occurs as the Station develops, while, in addition, it was found necessary to prosecute new lines of investigation to meet problems which have arisen chiefly as a result of insect depredations.

Three years ago the one aim and object of the Station was to find a variety or strain of cotton which would prove suitable to the soils, and climatic conditions of Southern Rhodesia. Thanks to the work of the Cotton Breeding Station at Barberton, this want was supplied by Parnell's discovery of his U.4 strain, the further improvement of which, by selection, was taken as the basis of operations at Gatooma. That this work has been carried out is amply demonstrated in the report in which Mr. Peat gives details of some of his most promising re-selections; several of these lead one to hope that, despite the ravages of bollworms, we can look forward with confidence to the time when cotton will take a much more prominent position in the farming operations of the country.

But for the severe damage caused by American bollworms last season, yields throughout the country would have been much higher than they were. The fact that this occurred, moreover, in a year in which cotton fell to pre-war prices, renders it probable that the industry will suffer a check in the rate at which it is likely to expand in the immediate future. If one accepts the long view, however, this may be all to the good, as it is felt that the industry will ultimately be established on a surer foundation if its rate of development, in the initial stages, is maintained at a pace which does not outrun the output of improved strains from Gatooma, and the increase in our knowledge of insect pests, and methods of combating them.

The system of distribution of these improved strains continues to find favour with the farming public whose ready support of the scheme is gratefully recognised; it is a fact that augurs well for the future of the industry, and is in itself a tacit acknowledgment of faith in the work

which is being undertaken jointly by the Government of Southern Rhodesia, and the Empire Cotton Growing Corporation.

Considerable attention has necessarily been given to the American bollworm problem, since it is imperative that every effort should be made to counter the activities of this pest. There is reason to hope that fair to good yields may be expected by the adoption of closer spacing as shown in the trials which are detailed in the report. These trials have been conducted, both on the Cotton Station at Gatooma and in the districts where the co-operation of a few progressive farmers has corroborated the results obtained at the Station.

The negative evidence afforded by the results of the fertiliser trials is most opportune at the present time, when the agricultural community is not in a position to risk any expenditure on artificial manures unless there is definite evidence that such expenditure will be more than repaid by enhanced yields.

The method of trapping for stainers as described in the report is being adopted by a number of farmers throughout the country, and developments in this connection will be awaited with interest. While the actual amount of damage to lint is not as great as might be expected, there is reason to believe that the germinating power of cotton seed in Southern Rhodesia may be greatly reduced by stainers. Now that there is an ample supply of seed to meet requirements this difficulty can be overcome by employing a heavier seed rate.

The report mentions the official visit paid to the Station by the Honourable the Premier, and other distinguished Members of the Executive Council, as well as by Members of the Legislative Assembly.

The Government of Southern Rhodesia has financed the entire work of the Station, with the exception of the salaries of the Empire Cotton Growing Corporation's staff in the country. Their generous aid in this respect, coupled with their keen, and practical interest in the work, is gratefully recorded.

COTTON-BREEDING STATION, GATOOMA; REPORT FOR THE SEASON 1929-30.

BY

J. E. PEAT.

The results and observations recorded in the following report represent the combined work of the members of the Staff of the Station, Mr. A. N. Prentice and the writer, Mr. A. G. H. Rattray who throughout the season has performed the duties of farm foreman, and Mr. J. Trinder,

recorder, who has been responsible for the major portion of the routine recording. Mr. A. H. McKinstry has been on study leave throughout the year.

Summary.

The season has been an interesting and very important one, dominated by the attack of American bollworm. Important progress has been made.

Throughout the country there have been bollworm attacks varying in intensity, light in some localities, heavier in others, but probably in few places more heavy than on the Station. Some very good crops have been obtained, some failures, and a big proportion of moderate returns.

The experimental and breeding results, therefore, must be examined in the light of this attack, and probably appropriately so for the rest of the country. At the moment it looks as if the possibility of serious bollworm attack were the remaining big obstacle to fully successful cotton growing in Southern Rhodesia. A proposed extension of records and detailed observations into the districts is discussed in the report.

Climatically the season was moderately favourable to cotton on the Station, though, as shown, the drought periods may have been unfavourable to the production of strong cotton. Good rains enabled planting to commence in the middle of November, and good stands were obtained. The two drought periods also had the effect of pushing the main flowering into March, where it was caught by the American bollworm attack, thus accentuating the serious effect of the latter. Low temperatures in the latter half of June and in July prevented the setting on the Station of a potential second compensatory crop by the better strains, after the dying away of the bollworm infestation.

Jassid attack was similar to that of other seasons. The susceptible strains collapsed, and in their powers of resistance, strains previously recorded as resistant were satisfactory. Stainers were numerous, but again it is considered that a fair measure of control was effected by the system of trapping practised.

The bollworm infestation, mainly American, developed on the Station early in March. It was heavy. Several of the Gatooma U.4 selections, especially /64, and re-selections from /64 and /26—64/7 and 26/4—which are prolific and hold on to a good early crop, showed up markedly well contrasted with neighbouring U.4 selections, and with the U.4 mixed bulk, the commercial U.4 of the country.

Observation blocks of jassid-resistant strains other than U.4 failed completely under the bollworm attack.

Strain /64 appears a satisfactory family, and seed from its multiplication is being issued to growers this year. The breeding and issue of these strains may help considerably in the setting of a payable crop in spite of bollworm.

The majority of growers obtained successful results in the multiplications of the U.4 Special Bulk, issued in 10-lb. packets last season. This is discussed below. Several secured a yield exceeding 1,000 lbs. of seed cotton per acre, at a very thin seed rate, and wide spacing.

The results on the Station, supplemented by replicated trials undertaken by a few farmers in other districts, show for the season the marked benefits of a closer spacing than that which is being adopted. The accompanying graphs bring out the nature of this increase. Even with a very bad bollworm attack, had prices been better, the yields at the closer spacings would have presented almost a paying crop contrasted with the poor returns at the wider spacings ; trials from a good crop, practically unattacked, at the 1,000 lbs. per acre level, are also markedly in favour of the closer spacing. The possible dangers of a closer spacing are discussed.

Other possible methods of bollworm control are outlined ; these include experiments in mechanical dusting with calcium arsenate, and the breeding up and liberation of egg parasites—possibly complementary measures—also the dusting for a heavy brood attack not checked by the egg parasites.

Results from fertiliser trials do not give satisfactory evidence of improvement in yield, quality, or earliness from fertiliser applications in the normal way. Further experiments are required, including work in other districts.

Good lint quality is showing up in the better-yielding re-selections, including good length, fair strength, uniformity and satisfactory ginning percentages. In a difficult year for strength, several of the better lots compare very favourably with the bulk and neighbouring strains in this quality. Progress is being made in the analysis of the range in these qualities. Length irregularity is discussed.

Station.

Some 310 acres are now under the plough, in addition to tree belts, building blocks and roads. Each season additional shelter belts are being planted. A ginnery building was completed early in the season. A new house is nearly completed at the time of writing. It is being

erected by the Public Works Department, bricks and unskilled labour being supplied from the Station. A farm office, farm store, and implement shed, are being built with Station labour.

Season.

Climatically the season might be described, for the Station, as moderately favourable to cotton on old land.

The rainfall distribution is shown in Fig. 1, a total of 29·23 inches. The planting season was relatively early and good. A good rain on November 14th enabled final harrowing to be done and planting to be started. This was followed by good rains on the 22nd, 23rd and 26th. Good stands were obtained and the young plants got well away. A dry spell during the latter part of December and early January lasted longer than was good for the cotton, though the crop did not show much sign of distress. Growth was slowed down in January (Fig. 7). This must have had the effect of slowing down the flowering curve in February, pushing the heavy flowering period, the peak period, late (*cf.* Fig. 2, 1927–28). Thus a large proportion of the heavy flowering which might have been expected in February was pushed into March and was caught by the heavy bollworm attack. This drought period together with the drought period in February thus had the effect of accentuating, by reason of the low yields they caused, the seriousness of the heavy bollworm attack.

This delay in the peak period of heavy flowering meant a delay in the main period of boll opening, throwing the main period of boll development into a period of lower temperatures, a result which was especially marked this season (Fig. 2). For an early season the main pickings were distinctly late throughout the country. This late development of the crop in a period of lower temperatures may account for much of the softness in the lint.

A further drought period started at the end of January and continued for the first three weeks of February. Maize suffered badly. Cotton appeared to stand the drought relatively well, but growth first slowed down and then practically stopped ; the smaller plants showed signs of being stunted. These two drought periods, coming in a year of early and heavy bollworm attack and a year of low dry weather temperatures, must have reduced the potential crop very considerably by throwing it late ; to a certain extent they may also explain the softness of much of the lint.

These records bear out the necessity in Rhodesia of planting as early as the rains permit ; cotton should probably be given priority in planting to maize and most of the other crops grown.

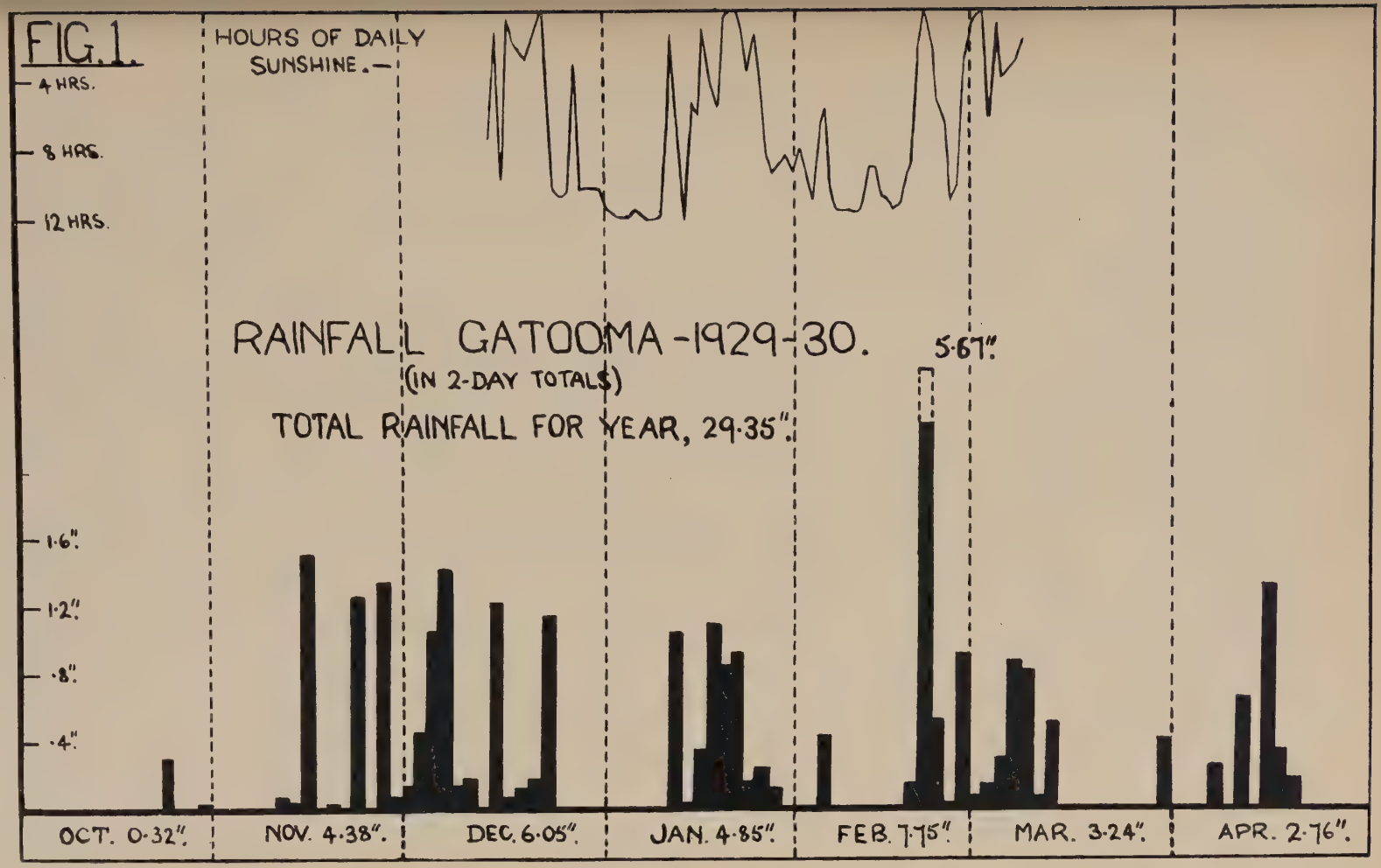


FIG. 1.
HOURS OF DAILY SUNSHINE.—
4 HRS.
8 HRS.
12 HRS.
RAINFALL GATOOMA - 1929-30.
(IN 2-DAY TOTALS)
TOTAL RAINFALL FOR YEAR, 29·35".
5·67".
1·6".
1·2".
·8".
·4".
OCT. 0·32".
NOV. 4·38".
DEC. 6·05".
JAN. 4·85".
FEB. 7·75".
MAR. 3·24".
APR. 2·76".

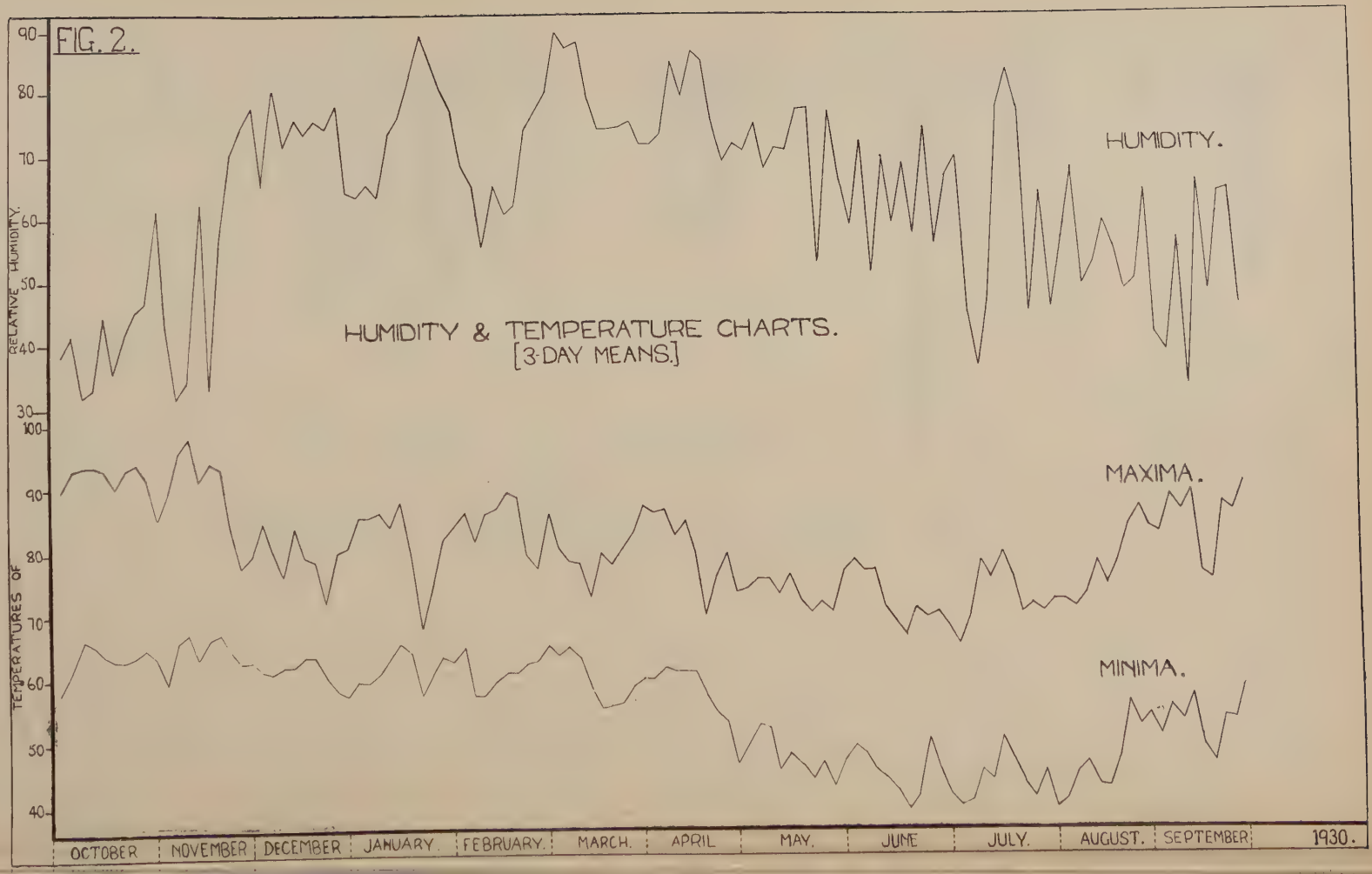


FIG. 2.
HUMIDITY & TEMPERATURE CHARTS.
[3-DAY MEANS.]
RELATIVE HUMIDITY.
TEMPERATURES OF
HUMIDITY.
MAXIMA.
MINIMA.
90
80
70
60
50
40
30
100
90
80
70
60
50
40
OCTOBER
NOVEMBER
DECEMBER
JANUARY.
FEBRUARY.
MARCH.
APRIL
MAY.
JUNE
JULY.
AUGUST.
SEPTEMBER
1930.

The drought was broken by a fall of over 5 inches on February 20th. This caused a heavy shedding of buds, squares, and young bolls, causing a further loss of the potential earlier crop (Fig. 7). The shedding graphs (Fig. 7A) illustrate this well. Were it not for this peak of shedding, the percentage of the loss attributable to bollworm would show up more markedly than it does.

March was relatively a dry month. Low temperatures and cold winds in the latter half of June and in July, prevented the setting of a compensatory second crop after the bollworm attack died down. The better strains showed a fair potential crop, which however did not develop.

On the Station frost was not experienced. The lowest minimum temperature recorded was 34·5° on July 29th. Neighbouring farms had frost during the night.

Insect Attack.

Bollworm.—The season on the Station was completely dominated by a more or less continuous attack of American bollworm, starting from the beginning of March, rising to peaks caused by the two main broods in the middle of March and the middle of April, and continuing into May (Figs. 3 and 4). The attack was irregular in its incidence, but, speaking generally, it cleared off most of the middle and all of the top crop, from the better and earlier, and practically everything from the poorer and later, strains. Most of the growers in the country suffered in varying degrees, few, however, probably more heavily than the Station, so that the reactions of the strains and Mixed Bulk under the various treatments on the Station may be taken as reactions to a bollworm attack which was probably as heavy as any in the country this past season. A number of growers suffered little or no damage, and with many others the attack developed later than on the Station, quite moderately good crops resulting.

Figs. 3 and 4 illustrate the nature of the attack ; as can be seen, the serious damage was done by American bollworm in three or more main broods. From the beginning of February to the end of May in the daily collection of bollworms for record taking, 72% were American (*Chloridea obsoleta*), 9% Sudan (*Diparopsis castanea*), and 19% Spiny (*Earias* spp.). For March the percentages were 83% American, 2% Sudan, and 15% Spiny ; and for April, 75%, 12½%, and 12½% respectively.

American bollworm is a particularly serious pest. With an early attack, a given number probably do a much greater amount of damage in their lifetime than an equivalent number of Sudan bollworms.

FIG. 3.

BOLLWORMS : SEASONAL DISTRIBUTION

DAILY COUNTS ON 100 MARKED PLANTS, SCATTERED.

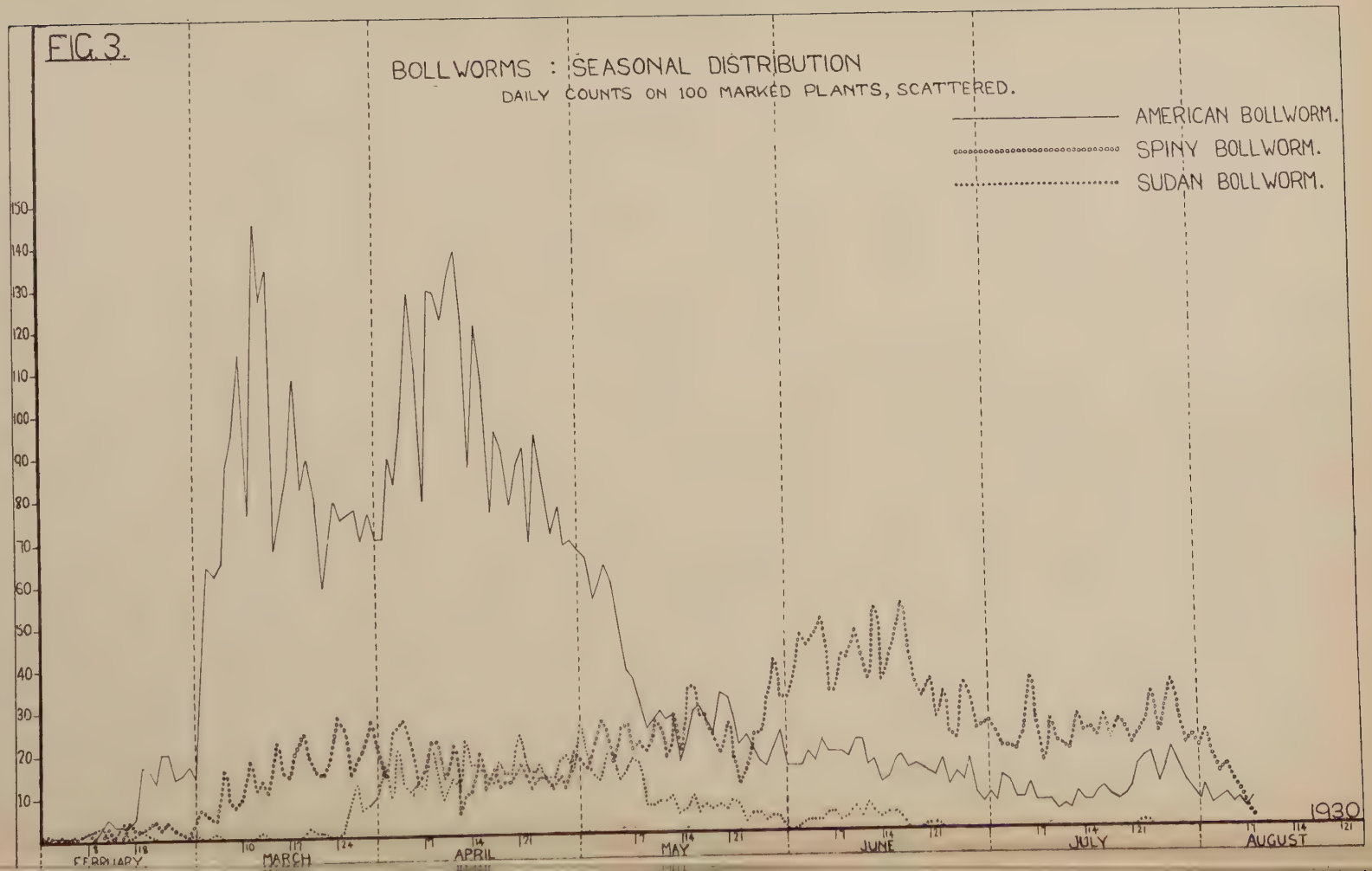
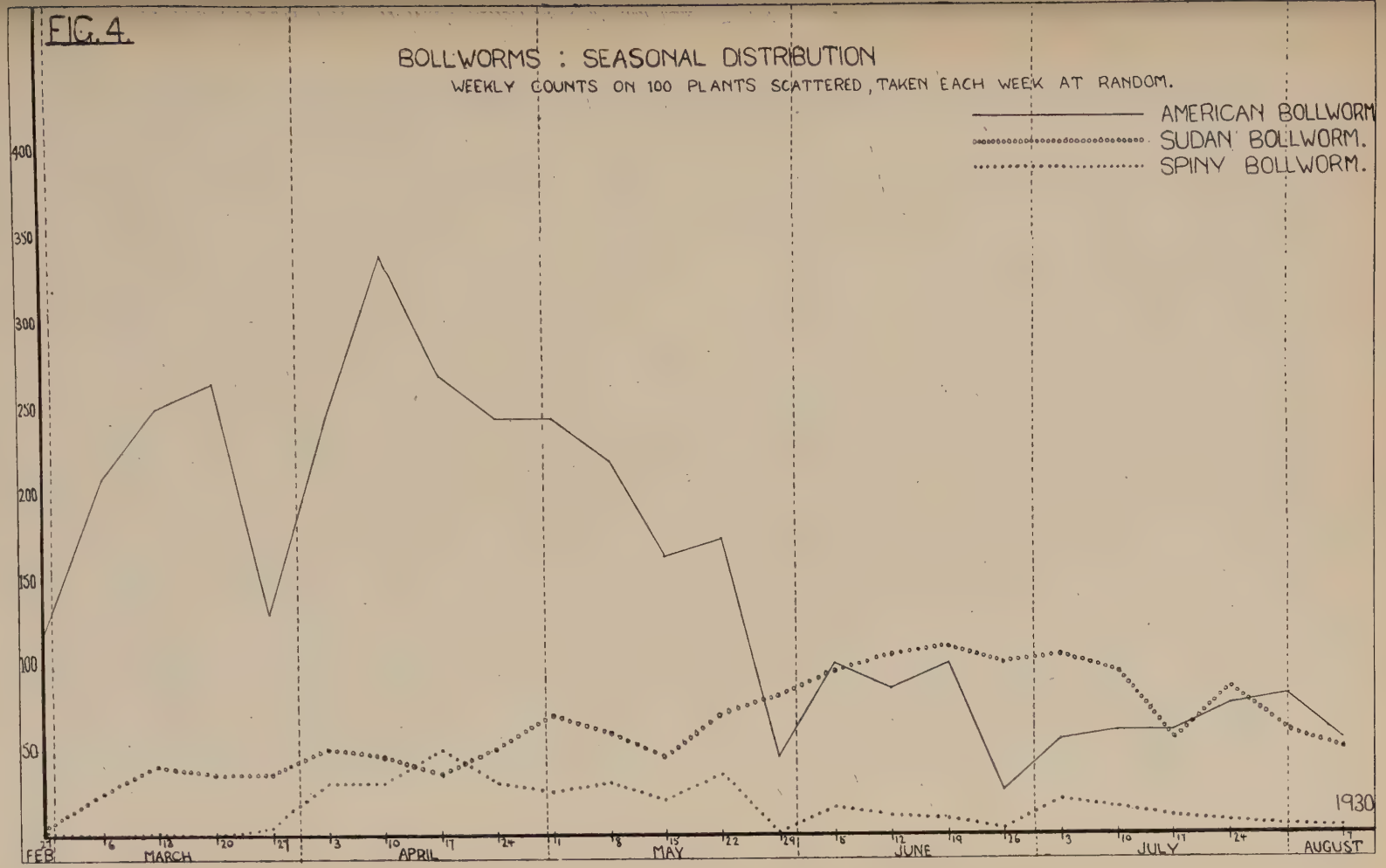


FIG. 4.

BOLLWORMS : SEASONAL DISTRIBUTION

WEEKLY COUNTS ON 100 PLANTS SCATTERED, TAKEN EACH WEEK AT RANDOM.



They specially attack buds, flowers, and the younger bolls, destroying in a relatively short period a big proportion of a potential crop. They move about a great deal in feeding, even the young larvæ are very active, dropping from fine threads if touched. They appear to have a special liking for the flowers. At the height of the attack a large proportion of the open flowers had American bollworms inside, eating the stamens, the pistils and the corolla. They attack the older formed bolls to a very much less extent, and when they do, they seldom eat them out. For this reason, in a sudden attack, if it is not excessively severe, a big proportion of the bolls already well-formed escape damage, or are only slightly damaged. If the type of attack experienced in the country during the past two seasons is characteristic of that which may usually be expected, this points to the necessity of forcing on an early crop by breeding and by cultural methods.

Sudan bollworms are different: these, especially the older larvæ, are found mainly in the older well-formed bolls, which they tend to eat out. Thus in countering a Sudan bollworm attack, the earliness of a crop is not so important as a consideration of the prolific nature of the strains, probably a larger number of smaller bolls in preference to a smaller number of bigger.

From Fig. 3 it may be seen that the attack during February was slight, a few Americans, an occasional Sudan, and one or two Spiny bollworms. At the beginning of March there was a sudden bad attack of American. It is possible that a certain proportion of the very small bollworms in February might well have been missed by the native recorders until they got accustomed to the work, and therefore it is possible that the curve in the last week in February should rise more sharply than it does in Fig. 3. Towards the end of February the larvæ hatching out from the first heavy egg-laying were mostly very small. Heavy damage was caused to the young buds and flowers, and from about March 5th flowering fell away very rapidly causing a sudden and very definite finish to the flowering season, which after an early start had already been thrown late by the drought period. The flowering curve was then a mere fraction of the potential—all the Station records must be examined in the light of this.

The relative proportions of physiological boll shedding, and of that caused by bollworm attack, will be dealt with later.

The American bollworm attack remained very bad through March and April, with peaks in the curve in mid-March and mid-April, decreasing in early May when little was left on the plants. This was too late for compensatory fruiting, as the temperatures were low and the flowers were not setting.

The collection of bollworms for the counts showed in the main American bollworms of all sizes present more or less throughout the attack. There were probably two or three main broods, a heavy egg-laying in February and again at the end of March. But there must have been in addition a certain amount of continuous egg-laying. The first Americans in February were mostly very small, active—hanging from threads—the hatching from the first heavy egg-laying. They were mostly well grown in the collections made in the second part of March, and then mostly small again at the beginning of April, the hatching from the second heavy egg-laying. During April and May there was probably a merging of more than one brood, which would account for the presence of bollworms in all stages of development.

Spiny bollworm remained relatively constant through March, April and the first half of May, increasing to quite an extent in the second half of May, June and July. This increase is interesting. This type is found frequently in the veld feeding on various species of Hibiscus which are very common throughout the country.

On the Station, Sudan bollworm has been a minor pest this season—a steady small nibble through April and May—the larvæ being very small from an egg-laying at the end of March, and practically entirely full grown at the end of April. Coinciding with a heavy attack of American, the Sudan bollworm must have been checked considerably by the predaceous habits of the American. This is the first season that Sudan bollworm has been a pest of annual cotton on the Station, and with the knowledge of its behaviour in other countries it is recognised that it may become more serious in subsequent years. Consideration is being given to this in the planning of general bollworm control measures.

Ratoons.—An acreage of some four acres was ratooned on October 5th, 1929, as an observation trap crop. The area was flowering by the first week in November. Towards the end of November very small Sudan bollworms were seen on the plants, and occasional American and Spiny bollworms; in December, there were mainly Sudan, with occasional American and Spiny bollworms. On January 8th and 9th counts were made on scattered groups of plants through the plots. On a total of 766 plants, 379 bollworms were collected, *i.e.*, 0·5 per plant, the distribution being 53·8% Sudan, 16·9% Spiny, and 29·3% American. The area was then cut back, leaving one stalk per plant which was carefully picked clean. On January 17th a further count was made on scattered groups of plants, 639 plants in all. 123 bollworms were collected, *i.e.*, 0·2 per stalk plant, the distribution being 32·5% Sudan, 23·5% Spiny, and 44% American. The stalks were

stripped, leaving only the terminal buds and leaves and one side shoot. These were picked clean. A further count was made on January 31st after which the ratoons were uplifted; 449 plants were examined in scattered groups as before. 244 bollworms were collected, *i.e.*, 0·54 bollworms per stalk plant, the distribution being 70% Sudan, 27% Spiny, 3% American. All the bollworms except the Sudans were very small, obviously from a new egg-laying. The results show that should Sudan become more serious, good results might possibly be obtained by the extensive use of ratoon trap crops. In farm practice ratooned trap crops would have to be fairly regularly watched, requiring probably regular grazing.

Nothing is known about the natural food plants of Sudan bollworms nor how much migratory movement there is by the first moths, at the beginning of the season, carrying them into the potential cotton areas. *Cienfugosia*, so far as is known, is not present or only rarely present in the country, and wild cotton plants are very rare. A larva very much like Sudan bollworm was found feeding on an abutilon in the Zambesi Valley near Tete. Unfortunately, it could not be bred out; but seed of the abutilon, which was a common plant of that area, was collected for the malvaceous collection. This coming season further work will be done with ratooned trap crops and a wide collection of malvaceous plants will be planted out on the Station in an attempt to get some further information about the natural food plants.

For the records which were used for the construction of Fig. 3, bollworms were collected daily from a hundred marked plants scattered in groups of five throughout all the bulks of cotton grown on the Station. These marked plants were thus cleaned of bollworm every day.

The graphs show the considerable movement of bollworms that must have taken place within each twenty-four hour period, seeing that the bollworms collected for each day represent new arrivals, the plants having been cleaned, so far as could be seen, twenty-four hours previously. It was thought that this method might give an unfair picture of the attack and of the relative proportions of American, Sudan, and Spiny bollworms; supplementary records were therefore taken weekly on one hundred plants scattered in groups of five. Different groups were taken each week, maintaining roughly the same scatter. The general form of graph obtained, Fig. 4, is much the same as Fig. 3. The proportions of the three groups of bollworms are very similar throughout the season (Table I); though of course numbers per plant per day are very much less in Fig. 3 than in Fig. 4.

TABLE I.

Bollworm Records—Daily and Weekly Pickings.

Period.			*American.*	*Sudan.*	*Spiny.*
March	Daily	Totals	2,190	41	404
		Percentage	83	2	15
	Weekly	Totals	855	5	135
		Percentage	86	½	13½
April	Daily	Totals	2,689	440	438
		Percentage	75	12½	12½
	Weekly	Totals	1,098	142	178
		Percentage	77	10	13
1st March to 31st May	Daily	Totals	6,052	744	1,542
		Percentage	72	9	19
	Weekly	Totals	2,804	257	543
		Percentage	78	7	15

There was not the heavy attack of American bollworm on the maize that there was last year. It would almost seem that the American bollworm brood which last year attacked the maize in March, this year attacked mainly the cotton instead ; and that the next brood coming along at the end of March and early in April, attacked the cotton as it did last year, and as in the 1925–26 season.

In April on the Station, there was a very sudden and very heavy attack on the sunnhemp which was then being ploughed in, possibly part of the second main brood. Flights of swallows put in an appearance and appeared to be feeding continuously on the larvæ. A count on April 19th, after the swallows had been feeding for two or three days, showed a population of forty-two, mostly well grown, to the square yard of sunnhemp. Another area of sunnhemp in the Bagley portion of the Station was much more lightly attacked, and no other similar attacks were seen in the district.

Trap crop maize was planted at intervals as in other years, but did not appear to be particularly attractive to the American bollworm. Counts in the middle of April showed on the average only every third plant attacked, in marked contrast to the very heavy attack on the trap crop maize by the April brood last year.

These attacks at Gatooma of the past two years are very different from the sort of attack which is experienced around the Corporation's

Station at Barberton. There the attack seems to consist of a heavy infestation by one brood, the next brood probably moving on. Control measures will therefore probably be different in the two areas.

It is essential now to get a more complete picture of what is happening in the districts. It is thought that most of the damage this year was done by American bollworm, but this is only based on scattered observations in touring. It is necessary to have records of the attacks from these areas, the periodicity of serious attack, the seasonal distribution, the dates of the main broods, and an analysis of the attack, *i.e.*, how much of the attack is due to American, Sudan, and Spiny bollworm respectively. This coming season records of this nature will be made by native recorders, trained on the Station, in sub-posts in the Mazoe, Lomagundi, and Bulawayo Districts. They will be under white supervision, and supplementary general observations on pests, on natural food plants, broods and attacks on other crops will be made by the supervisor throughout the areas. The observations on bollworm attack in the country—though scanty—appear to show the main damage to have been done by American bollworm, and in March and April. Measures of control must, for the present, be based on this, but it is being borne in mind, in considering possible control measures, that attacks of American bollworm may occur earlier in the season, and that Sudan bollworm may become more serious than it is at present.

Two seasons out of five on the Station, bollworm damage has been negligible, and in the past two seasons a proportion of growers have escaped attack. Thus, even without direct measures of control, such as parasite liberation or dusting, there will be seasons when the natural factors are unfavourable to bollworm. In a season of bad bollworm attack, such as this, only a proportion of growers were severely hit, and some of those who suffered badly last year had a light attack this year, and *vice versa*.

Planting cotton as early as the rains permit would appear to be important, and probably priority over maize should be given to it. As will be described later, multiplications of one or two Gatooma sub-strains of U.4 have shown up over the past two years of bollworm attack on the Station as markedly superior to the Mixed Bulk U.4, which is the general U.4 grown in the districts, setting and holding on to a fair early crop. Yields from spacing trials have shown the benefits of a closer spacing than that in general use. The closely spaced plants of the better strains have given a fair yield this past season, in spite of the bad bollworm attack contrasted with the poor returns of the Mixed Bulk at the commercial spacing.

Parasites.—Collections of larvæ were bred out this year, as last year, in continuation of the investigation of larval and pupal parasites. Tachinids, Sturmia spp., and Sarcophagids were bred out in fair numbers from American and Sudan bollworm larvæ and pupæ throughout the season, the greatest percentage of parasitism being in March and early April. Higher percentages were bred out from American than from Sudan bollworm. No parasites were bred out from Spiny bollworm larvæ or pupæ.

Tachinids and Sarcophagids appeared to be numerous in the lands, but seemed to do little in controlling the attack. Larvæ appeared to be mainly a fair size before being parasitised : most could pupate, and by that time had done their damage. A Chalcid was noticed towards the end of the season, very similar to, if not the same as, the Chalcid parasite of the Army Worm. The eggs were laid in clumps on the backs of the American bollworm larvæ. The grubs in hatching remained attached to the larvæ in clumps, and the pupæ in the dead bollworm looked more or less like peas in a pod. Theoretically, egg parasites would be potentially much more useful in the control of an attack than larval or pupal parasites, because they can make their effect felt before any damage is done. So far, no egg counts have been taken, nor collections of eggs made. But this coming year at Gatooma, and on each of the three sub-posts where the native recorders are to be stationed, collections of bollworm eggs will be made at intervals throughout the season, and these collections bred out on the Station, to find out what natural egg parasites are present, and the degree of natural parasitism. Cards of grain moth eggs stung with Trichogramma lutea are to be received daily from Barberton, as early in the season as they can be supplied, to be liberated at the Station and at the three sub-posts. Collections of bollworm eggs will be made in the areas in which the parasites have been liberated, and examined on the Station. The degree of parasitism will be a measure of the success or otherwise of the scheme ; if possible the results will be correlated with meteorological records. There would appear to be big possibilities in the daily liberation of egg parasites, though difficulties can be foreseen. They might control Sudan bollworm in the period when it is increasing, and American to a certain extent : a certain degree of colonisation might be obtained until the advent of the cold weather.

Close contact will be kept with Barberton, with their results of the liberation of parasites, with their work on other egg parasites, and their breeding technique. A start will also be made with parasite breeding at Gatooma on a very small scale with the immediate idea of allowing a heavier liberation in the two months from mid-February

to mid-April, when the main American bollworm egg laying might be expected. If the scheme were successful, extensive liberation from cold storage during these two months might be practicable.

Pentatomid bugs were found predaceous on bollworm larvæ, chiefly American.

Dusting.—Dusting experiments with calcium arsenate during the past two years have shown that only the younger American bollworms are killed by dusting, the older larvæ escaping. Dusting experiments were carried out in April, using hand-guns—not a very satisfactory method of application. Alternating strips of eight rows dusted and eight rows undusted, as controls, were used. Counts of bollworms were taken in the inner rows. Owing to the extent to which bollworms move about, wide experimental strips are necessary. Dusting was carried out in two areas on April 11th in the height of the second attack. 0·66 inches of rain fell on the night of the 11th and during the early morning of the 12th, necessitating a re-dusting. Counts made on scattered groups of plants in the strips, 100 plants in all, showed a 60% reduction of American bollworms on the dusted as compared with the undusted plots, no reduction in Sudan bollworms, and a very small reduction in Spiny (Table II). The American larvæ which survived were almost entirely well grown.

TABLE II.

Dusting Calcium Arsenate.

Counts of live bollworms on 100 Plants—scattered groups.

Undusted Plots.			Dusted Plots.		
American Bollworm.	*Sudan Bollworm.*	*Spiny Bollworm.*	*American Bollworm.*	*Sudan Bollworm.*	*Spiny Bollworm.*
411	58	37	166	63	23

Mid-April was too late for an effective dusting, as a large proportion of the larvæ were then well grown. If effective dusting could have been carried out towards the end of February and again at the end of March when the larvæ were small, after the heavy egg-layings of these two main broods, there would probably have been a heavy mortality and a big possible saving of the crop. It is recognised that dusting would be useless against Sudan bollworm. This coming season, careful dusting experiments will be carried out using an ox-drawn duster. Calcium arsenate is expensive in this country, costing at least 4s. an acre for the calcium arsenate for one dusting. But there might be a reduction in price if large quantities were to be used. The main difficulties would appear to be the necessity of applying the

dust at the right time after a heavy egg-laying, when the majority of the larvæ are small, and the necessity for re-dusting if rain should come immediately after the application.

Jassid.—The jassid distribution for the year is shown in Figs. 5 and 5A. It is much the same as last season. Durango collapsed in April; Bancroft showed the usual signs of distress; the Cambodias were highly resistant, and the U.4 lots satisfactory. The nymph counts were made weekly in a series of small plots in a jassid observation block from ten marked plants, five leaves on each or fifty leaves in all. As Durango started to collapse, only the younger leaves could be used for nymph counts on plants of that strain; these were small in area contrasted with the bigger leaves of other strains. Thus in the latter part of the season there was a much heavier attack per area of leaf in Durango than is brought out in the graph.

One the whole the U.4 Mixed Bulk lots throughout the country have shown up satisfactorily as regards jassid resistance, just a crop here and there suffering slightly.

The Mixed Bulk on the Station, which is segregating into a mixture of types, showed a small percentage of plants suffering. This small percentage of less resistant plants is sufficient, under conditions favourable to jassid increase, to allow a breeding up and thus a more general attack in the Mixed Bulk than there would have been had the plants been all uniformly resistant. The multiplications of the U.4 lots for issue were more uniformly resistant, and all appeared satisfactory. Use could not be made of differences in resistance in selection in the single plant lots, as all appeared satisfactory. There is undoubtedly a variation from lot to lot which a bad jassid year might show up. The counts on the plots of the U.4 multiplication lots in the jassid observation block show a slightly different type of attack from lot to lot (Fig. 5A).

Standover cotton, ratoons, or ratoon trap crops left in too long, would probably serve as breeding grounds for jassid, to give an early bombardment of the annual crop.

Stainers (*Dysdercus* spp.).—On the Station, stainers were numerous, flighting in from the veld—as numerous as in any year in the last five. A fair amount of stainer damage has been reported from other areas, varying in amount from farm to farm. It is considered that on the Station a fair check was effected by the system of trapping practised. A number of growers in other areas also obtained satisfactory results from the use of traps.

The results of the trapping on the Station are given in Fig. 6. The numbers represent the numbers of adults caught on or just around the

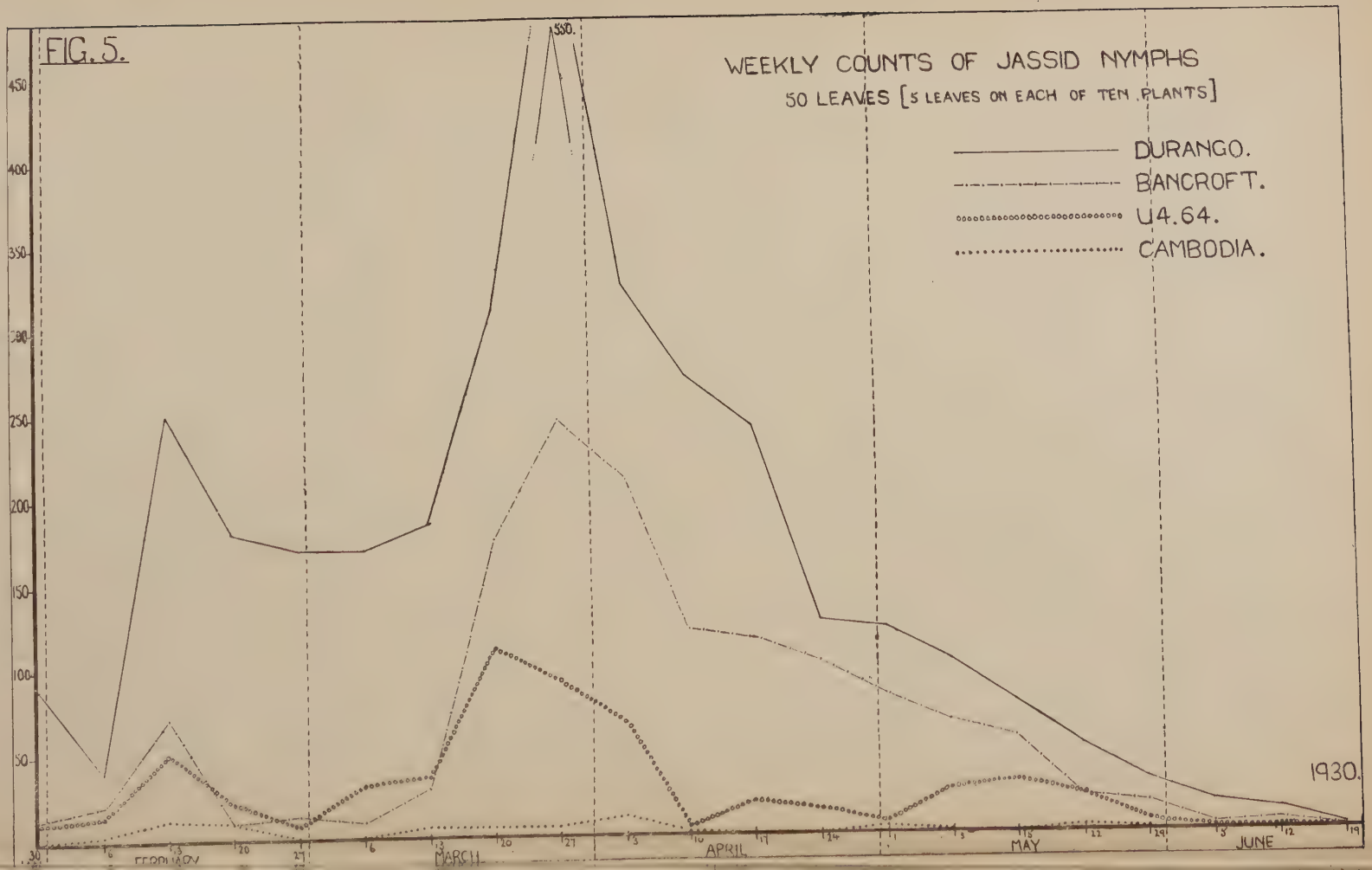


FIG. 5.
WEEKLY COUNTS OF JASSID NYMPHS
50 LEAVES [5 LEAVES ON EACH OF TEN PLANTS]
DURANGO.
BANCROFT.
U4.64.
CAMBODIA.
1930.
550
450
400
350
300
250
200
150
100
50
30
6
13
20
27
FEBRUARY
6
13
20
27
MARCH
3
10
17
24
APRIL
1
8
15
22
29
MAY
5
12
19
JUNE

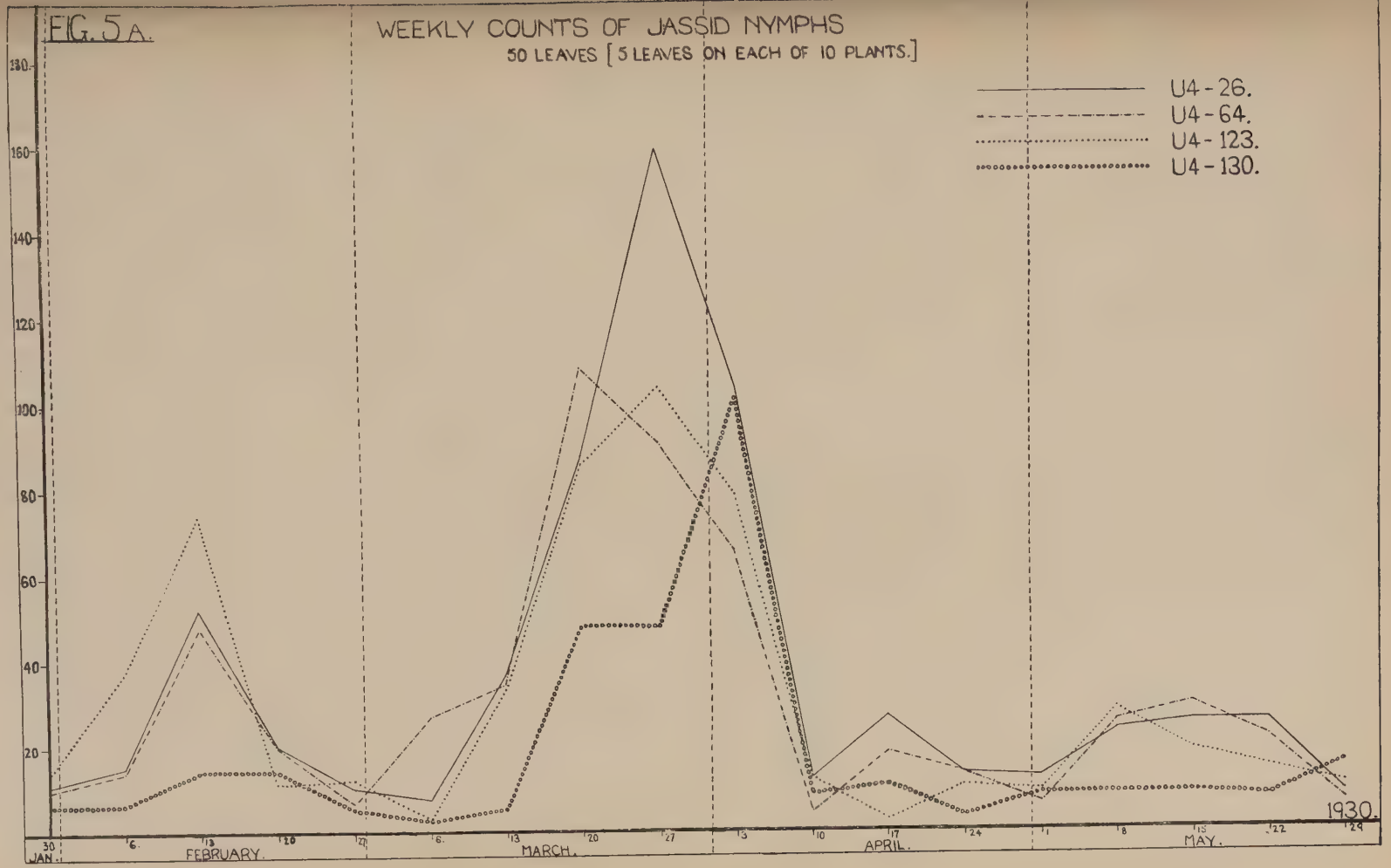


FIG. 5 A.
WEEKLY COUNTS OF JASSID NYMPHS
50 LEAVES [5 LEAVES ON EACH OF 10 PLANTS.]
U4 - 26.
U4 - 64.
U4 - 123.
U4 - 130.
180
160
140
120
100
80
60
40
20
30 JAN.
6
13
20
27
6
13
20
27
3
10
17
24
1
8
15
22
29
FEBRUARY.
MARCH.
APRIL.
MAY.
1930.

traps only, and do not include, as in other years, stainers hand-picked from the plants. During the season, from March 10th, twelve traps to the acre, scattered, were used. Possibly a greater number would have been more effective, but after experiment twelve to the acre was considered a satisfactory practical scatter in recommending the scheme to farmers—20 yards along the row, and, with a four feet spacing, every fifteenth row. Traps laid down on a system such as this are easily and quickly supervised. Within limits, the larger the traps the better. The normal size of trap used was $\frac{1}{2}$ lb. of seed. Heaps of $\frac{1}{8}$ lb., $\frac{1}{2}$ lb. and 3 lbs. of cotton seed gave catches of 570, 800 and 1,200 adult stainers respectively over equivalent areas. Traps were examined twice daily, during the morning and during the afternoon, though in practice once daily would probably be sufficient. The catches on the traps in the morning period were similar in size to those collected in the afternoon. The traps were placed under the shade of plants as described in other reports. When additional shade was provided by half paraffin tins, halved lengthwise, supported by sticks, an average catch 25 % heavier was obtained, but it is doubtful to what extent the extra labour and expense of providing additional shade is economical. Crushed cotton seed proved certainly no more attractive than uncrushed, and it is doubtful if it was even as attractive.

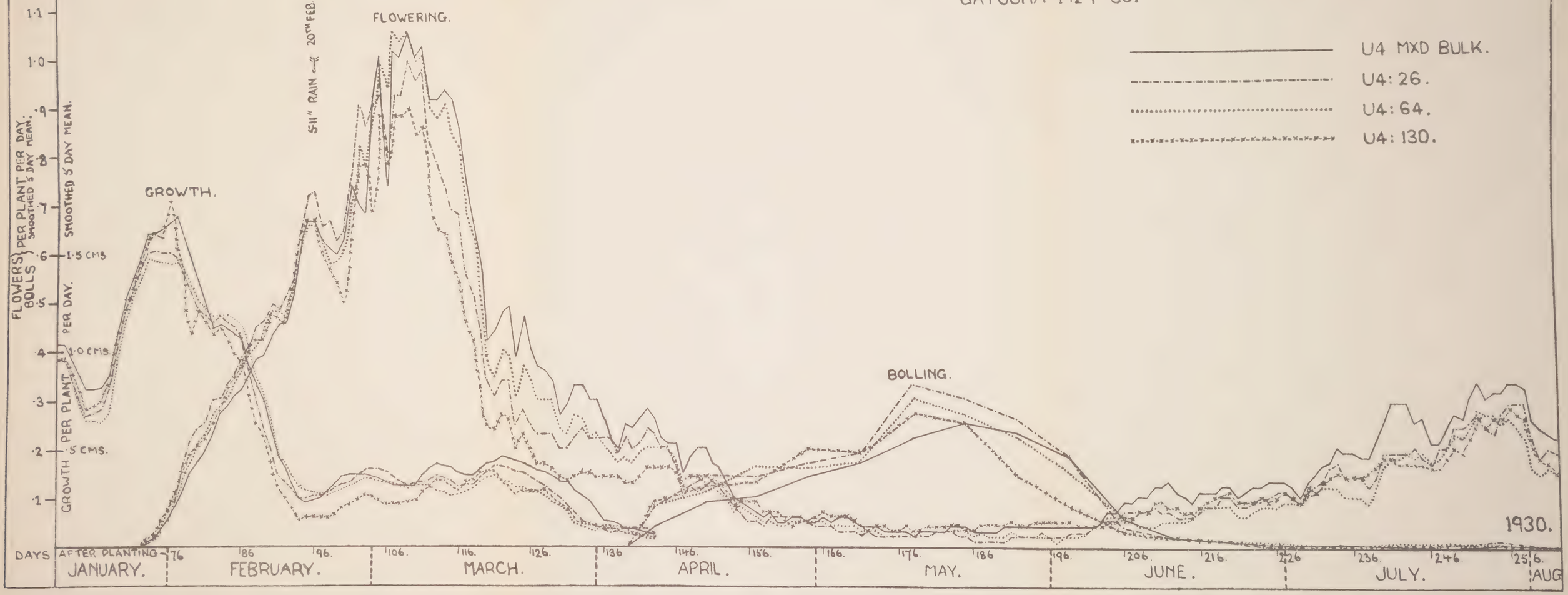
Two natives were responsible for the traps on about 70 acres. Commercially, one to 50 acres or more would be sufficient, with help in the lifting and renewing of the traps, and help in the destruction of nymphal broods when they start to hatch out. Traps were down for periods of from ten to twenty-five days according to the weather: they were renewed when unattractive, *i.e.*, when they germinated, or were eaten by white ants. The lifting and renewal of traps require additional labour. Until the beginning of April the traps were watered occasionally during the dry intervals, but though beneficial, this involves a considerable amount of labour and had to be discontinued. About 60 lbs. of cotton seed per acre were used for traps this past season. Trapping was carried out over $2\frac{1}{2}$ months, the normal size of traps being $\frac{1}{2}$ lb. of seed.

The first adult stainers were seen in the lands towards the end of February, when traps were put down. The numbers caught in the traps are graphed in Fig. 6. In March and April numbers were also hand-picked from the plants in record-taking, and destroyed during various field operations, selfing and weeding. Boys available from other work for short periods, an hour or two, or an afternoon, were put into the lands to hand pick stainers, and destroy nymphal broods. On March 24th the first nymphal broods were appearing on the traps,

FIG.7.

PLANT DEVELOPMENT RECORDS

GATOOMA 1929-30.



several days before the first bolls started to open; additional boys were accordingly put on to destroy them. Two boys, with a third helping when available, destroyed over 5,000 broods of nymphs in 35 acres between April 3rd and 13th. By the middle of April, with the crop opening, nymphal broods were to be seen in the opening bolls, more numerous than in other years, but not bad, and whenever it was convenient, boys were put through the lands destroying these. The number of stainers flighting into the cotton during the season must have been large, but only a small proportion of the crop picked was badly stained, and there is relatively little staining of the seed. The loss from the stainer attack could not therefore have been great and a very heavy infestation must have been prevented by the measures taken. It is difficult to say how much the crop would have suffered had no trapping and hand picking been carried out. As it was, it was kept fairly free of stainers until the bolls started to open, and even after that, multiplication was checked. This season there was no late crop to save, owing to the bollworm attack : no idea could consequently be gained of how a later picking would have fared. Several crops in the district, where no trapping was done, were badly stained. It is possible that if the conditions were really favourable to the spread of Internal Boll Disease, the stainers which escaped the traps would be sufficient to cause a serious amount of damage, as reports from other countries describe very serious stainer damage with quite small stainer populations. It seems that many of the later punctures in the present cotton-growing areas in Rhodesia do not infect the boll with Internal Boll Disease, and that under late season conditions, the disease itself is not as virulent as in parts of Nyasaland, the Union, and Portuguese East Africa.

Possibly this can be explained by the lower temperatures and the decreasing humidity as the season advances which produce conditions much less humid and warm than those that prevail in areas in which heavy Internal Boll Disease has been reported with a small stainer population.

In the present cotton areas in Southern Rhodesia, trapping and hand-picking of adults and the destruction of nymphal broods might be a most useful measure, while completely unsuccessful in other areas, more humid and warmer. In cotton, broods can only be reared on the seed, normally on the opening bolls or prematurely opened bolls. Young nymphs apparently cannot feed through the boll walls. Flighting in from the veld starts towards the end of February, and by the end of April temperatures are dropping and humidity decreasing, possibly reducing the virulence of Internal Boll Disease. The success

of the trapping and hand picking measures, therefore, probably lies in catching the first adults flighting in, destroying the broods from their egg-laying, and checking as much as possible their multiplication and the damage to the crop in the months of March and April, the more humid and warm months of the attack—at a cost, possibly, of about two shillings per acre for labour, and, say 1s. 6d. per acre for the value of the seed used. It is recognised, however, that stainers may do very serious damage in certain seasons, and under certain conditions—what these conditions are exactly we are only beginning to find out.

In Table III are given the proportions of the three species present on the Station at intervals throughout the season. The proportions were taken from adults caught in the traps.

TABLE III

	Dysdercus nigro-fasciatus (?)	*Dysdercus intermedius.*	*Dysdercus superstitiosus.*
28th February	100	41	23
10th March ...	100	27	57
29th March ...	100	138	27
2nd May	100	46	15

Aphis.—Aphis was troublesome on the Station in periods, but not as bad as last year. A number of growers in the neighbourhood were comparatively free throughout the season. The heavier attacks of aphis on the Station may be due to the type of soil and to the style of growth that is being obtained. It was noticed that an area of cotton, growing out well on land green-manured with sunnhemp the previous year, suffered less early in the season from aphis than the other lands.

Aphis was quite bad during the second fortnight of February and the first fortnight of March, a wet period, when definite harm was being done to the smaller plants. The attack then decreased, increased again in April, and decreased in May ; in June there was little aphis about, but quite a number of colonies were to be found in July. The bigger-leaved, leafy types, such as U.4/130, appeared to be more heavily attacked than the more open, small-leaved types, such as U.4/64.

Termites.—Termites again took a toll of the crop in February and during the dry spell in March—another distinct consideration in favour of closer spacing. On most farms a moderate loss must be expected from termites and allowed for in the spacing decided upon at the time of thinning. There was little loss of plants in the area on which cotton

was grown after sunnhemp ploughed in. Apparently there was sufficient debris to keep the termites supplied without their attacking the plants.

There was a certain loss of plants due to wireworms, Tenebrionid larvæ.

U.4.

Sub-strains—Yielding Power. –Three distinct strain types, U.4/64, U.4/26, and U.4/130, the most promising single plant lots that cropped fairly well under the difficult conditions of last year, were tested against the general Mixed Bulk in two sets of trials. Throughout the season development records were kept in the plots of a Fisher trial, on scattered groups of plants—growth, flowering, shedding (both natural and due to bollworm), and fruiting.

U.4/64 is a very good fruiting type, fairly open, slightly spreading, with smallish leaves, slender to medium wood, hardy and essentially sympodial—a good opener.

U.4/26 is a more vigorous type with moderately coarser fruiting and vegetative branches –closer sympodial internodes—often with one or two big vegetative branches, almost plants in themselves.

U.4/130 is a more fleshy type with big leaves and a big leaf surface, fairly close sympodial internodes and a tendency to grow woody under good conditions.

An important quality is the nature of the growth response of a strain to accidental topping, caused either in cultivation or by insect attack, and the nature of the growth response to a lightening of the load which the plant is bearing, owing to a heavy loss of bolls, flowers, and flower buds by bollworm attack. The desirable response is further sympodial growth rather than monopodial. /64 responds typically sympodially. There is rather a tendency in /26 and /130 to respond by forming vegetative branches, giving an ugly habit of growth for this country.

The development records are graphed in Fig. 7 with the shedding curves in Fig. 7A. Growth records were taken every third day on sixty plants for each strain, fifteen in groups, in each of the four plots, taken if possible in the inner rows of the plots, and in a normally spaced group of plants. Flowering and shedding records were taken on 200 plants per strain, scattered in groups, 50 to a plot. Plants were attacked by white ants and had to be discarded for growth measurements. The final numbers were thus reduced as the season advanced. Bolling records were taken from the same group as flowering records.

The checks in growth, due to the two drought periods, and the effects on the crop have already been mentioned. The flowering curves

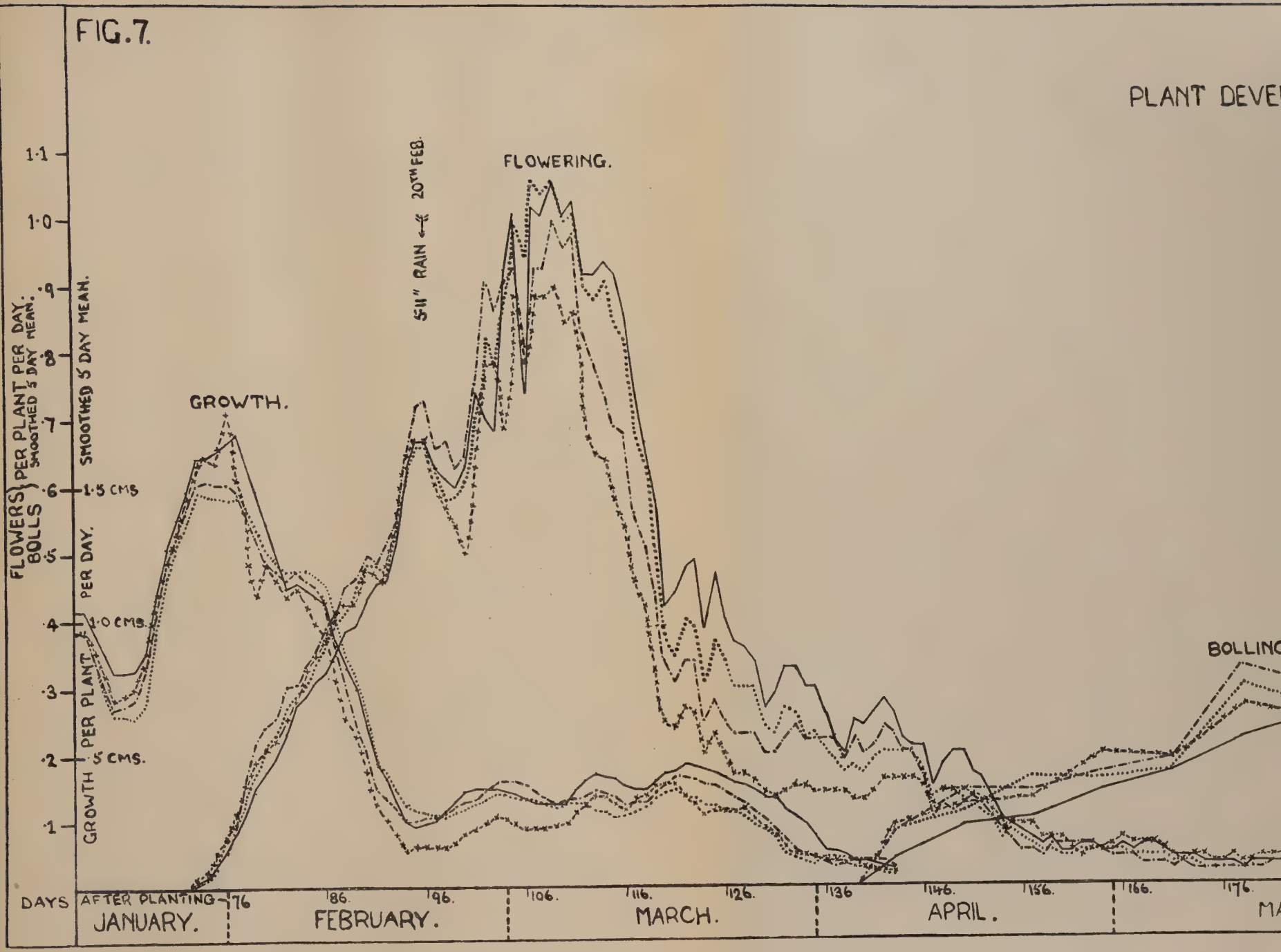
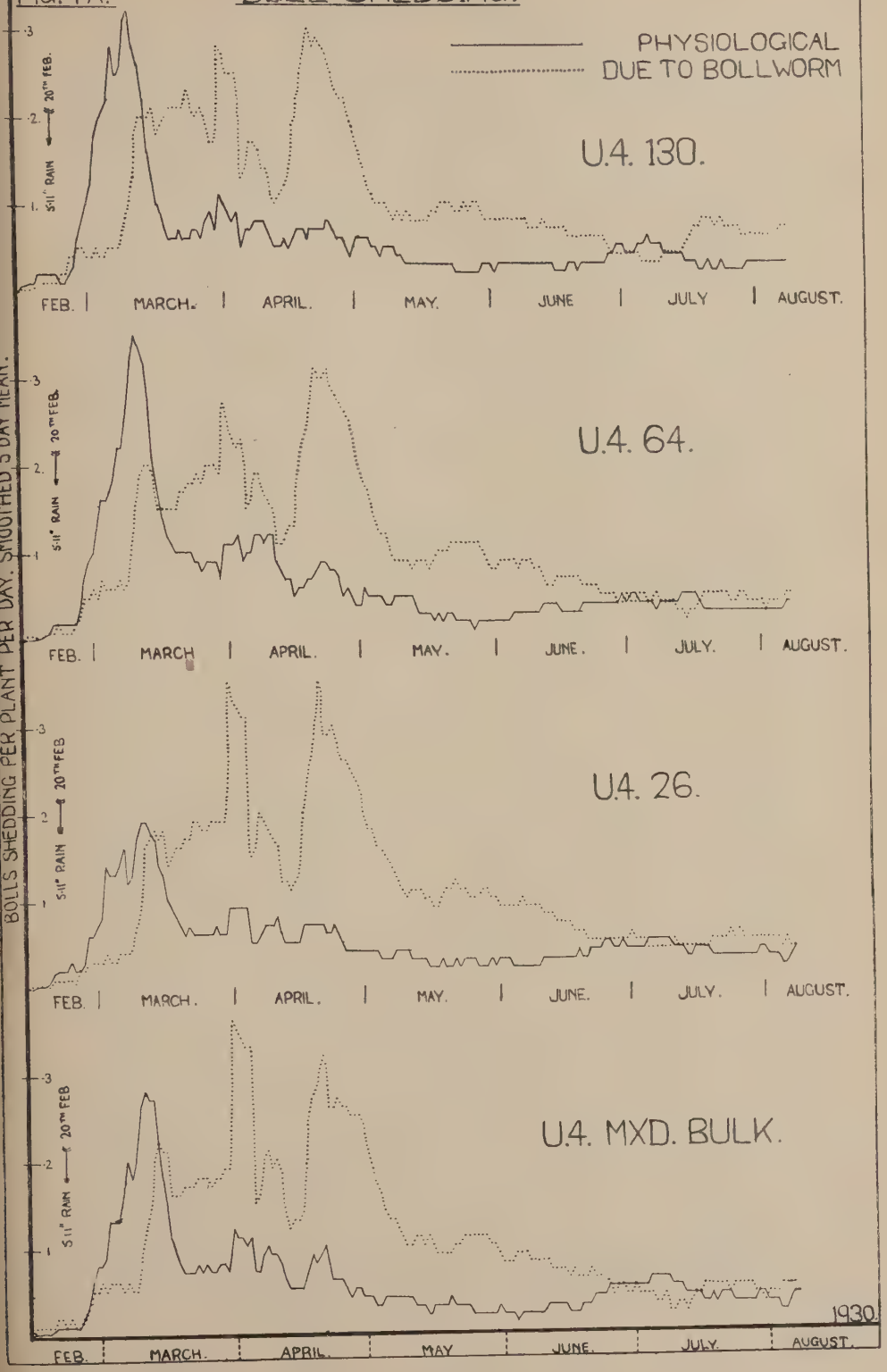


FIG.7.
PLANT DEVE
FLOWERING.
5·11" RAIN ← 20TH FEB.
GROWTH.
BOLLING
FLOWERS } PER PLANT PER DAY.
BOLLS } SMOOTHED 5 DAY MEAN.
SMOOTHED 5 DAY MEAN.
1·5 CMS
1·0 CMS.
·5 CMS.
GROWTH PER PLANT PER DAY.
1·1
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
DAYS AFTER PLANTING
76
86.
96.
106.
116.
126.
136
146.
156.
166.
176.
JANUARY.
FEBRUARY.
MARCH.
APRIL.
MA

FIG. 7A.

BOLL SHEDDING.



for the three sub-strains and for the Mixed Bulk are similar (with a lagging in /130)—more similar indeed than the final yield results would lead one to expect. The Mixed Bulk and /64 give the heaviest flowering. The bollworm attack cut the flowering off suddenly and early: from general observation /64 would otherwise probably have outstripped the others in the later flowering. The bolling curves are interesting in the falling away shown by the Mixed Bulk from the potential number of bolls judged on the flowering curve; though flowering as heavily as the sub-strains, it is distinctly the poorest yielder. Possibly its less uniform resistance to jassid may help to explain the result.

/64 and /26 are prolific, and they appear to have the power of holding on under difficult conditions to the early crop set. This was even more clearly shown in re-selection lots, /64/7 and /26/4, which set and held on to quite a fair early crop before the bollworm attack reached its height. The trial results (Tables V and VI) demonstrate more clearly than the records the superiority of the sub-strains over the Mixed Bulk under the particular conditions of the year. Maturation data were taken for dated bolls in plants in /26/4, 64/4 and 130/4 twice a week, starting on January 30th. As far as possible, flowers on the same groups of plants were used, twenty flowers for each strain at each dating. Table IV gives the results. There is a very big range

TABLE IV.

Boll Maturation Period.

Day of flowering.	U.4/26/4.		U.4/64/4.		U.4/130/4.	
	% No. of bolls held.	*Maturation Period of first 50%*	*% No. of bolls held.*	*Maturation period of first 50%*	*% No. of bolls held.*	*Maturation period of first 50%*
		Days.		*Days.*		*Days.*
January 30	80	67–68	20	61–67	40	60–61
February 3	80	63–67	85	57–66	45	59–65
6	90	63–68	85	63–68	45	61–63
10	60	75–77	65	63–77	15	65–76
13	65	73–75	45	66–75	20	71–74
17	10	78	5	85	—	—
21	5	88	—	—	—	—
24	30	61–74	15	75–84	—	—
27	25	60–76	5	104	5	74
March 3	5	81	10	82	—	—
6	20	80–81	5	100	10	68
10	5	77	5	85	30	71–77
13	20	76–82	10	72	10	67
17	10	80	—	—	20	75–76
20	40	69–76	15	78–79	5	62
24	15	64–76	15	73–78	5	69
27	5	99	5	99	10	56
31	5	95	—	—	—	—

of maturation period for flowers dated on the same day. This is true even for the same plant: two flowers, one near the tip of a long fruiting

branch, and one closer in on a fruiting branch at a higher node, differed by a considerable number of days in their maturation period. The number of flowers dated is probably too small to obtain a proper maturation figure. The column for maturation period gives the range of days for the setting of the first 50% of the bolls retained. The percentage of bolls retained by the plants of the total number tagged at each dating is interesting; /26/4 was the strain on the Station which set probably the biggest proportion of its potential crop before the bollworm attack, followed by /64/7; as a result these gave outstanding yields compared with the other material grown. /130/4 gave a much smaller proportion of bolls from the earlier flowering than /26/4 and /64/7, and this is probably what happened with several of the other strains which were good flowerers, and apparently early flowerers, but which finished up with poor yields. The numbers are small. Next year, if possible, greater numbers will be taken over a wider scatter, and for the Mixed Bulk as well as for outstanding strains.

Fig. 7A shows the proportions of the shed bolls which had been punctured by bollworms. Badly attacked and dead bolls were picked off and counted as shed, U.4 having markedly the quality of holding on even to dead, shrivelled bolls. Grown bolls slightly attacked are not recorded, nor is there any record of the proportions of natural bud shedding to that due to bollworm attack. After the bollworm attack increased in March, there was an enormous loss of buds and flowers; this is shown by the sharp fall in flowering in Fig. 7.

The proportion of boll shedding due to bollworm to natural shedding is interesting. The large peak of shedding caused by the heavy fall of rain on February 20th is marked and serious, because it was followed by a heavy bollworm attack. The lag before the shedding took place is interesting. This peak of shedding has lowered considerably the proportion of shedding recorded as due to bollworm.

The power of /26 to hold on to the early crop set is shown, but this is not illustrated so well with /64. /64 is more spreading in habit and with wider internodes than /26. It was much more badly knocked about and flattened by the storm of February 20th, and suffered more as a result. This is shown clearly in the shedding curves, by the greater shedding of /64. /130 is a poorer and slower flowerer, but is probably more jassid-resistant than the other lots and as good in holding on to its bolls. The lower yields are due to its poorer capacity for flowering.

The curves of shedding due to bollworm bring out well the two main broods of March and April, the lag of the curves compared to the bollworm curves being due to the greater loss caused as the bollworms increased in size and to the lag in shedding after the application of the stimulus.

U.4 Sub-Strains—Yield Trials.—Two sets of trials were laid down to test Mixed Bulk against /64, /26, and /130, one a Fisher trial in which the development records were taken (plots 1/45·4 acre, rows 4 feet by 15 inches, a Latin Square); and the other on the half-drill-strip principle (plots 1/22·7 acre, four rows 4 feet by 15 inches per plot, eight replications).

Pickings were taken in the second week in May (9th May for the Fisher trial, May 13th to 15th for the half-drill-strip trial), and the second week in June (11th for the Fisher and 12th to 13th for the half-drill-strip). U.4 Mixed Bulk was the control in both. The stands in the half-drill-strip trials at the time of the second picking, and in the Fisher trials at August 15th, are given in the Tables V and VI. The poorer stands of the U.4 Mixed Bulk would favour it, if yields were to be considered on the 100% stand basis. The Fisher trials were planted as development record plots and to gain experience in the use of the Fisher method for the analysis of variance. The results supplement the conclusions of the half-drill-strip trials. Under the conditions of the year the probable superiority of the sub-strains over the Mixed Bulk is shown, /64 being outstanding. The bollworm attack on the Fisher trials was both lighter and later. General observations on the Station support the observations on the heavy yielding powers of 64. It was distinctly the best yielder in the jassid observation plots. The plants in the multiplication area carried quite fairly for the season, and the best /64 re-selection—/64/7—was outstanding, being the best on the Station. /64 and /26 were the two outstanding single plant lots in the 1928–29 season. /64 and a /26 Special Bulk will be multiplied by a number of growers throughout the country this coming year, and it is hoped to arrange a number of trials by growers in Mazoe and Lomagundi of /64 against the general Mixed Bulk.

TABLE V.

U.4 Sub-Strain Trial—Half Drill Strip Layout.

Strain.	*Mean Yield of seed cotton per plot.*	*Equivalent yield per acre.*	*Diff. from Mixed Bulk.*	*M.Diff. / S.D. of M.Diff. (= Z).*	*Significance.*	*Stand.*	*Remarks.*
U.4/Mixed Bulk	5.4 lbs.	123 lbs.	—	Control	All significantly heavier yielders than U.4 Mixed bulk.	71%	8 Plots per strain (Control 12), plots 1/22·7 acres. Fertilizer 200 lbs. supers plus 50 lbs. ammonium sulphate per acre; soil red loam. American bollworm attack very bad.
U.4/26	8·9 lbs.	202 lbs.	+79 lbs.	1·15		74%	
U.4/64	13·8 lbs.	313 lbs.	+190 lbs.	>6		77%	
U.4/130	6.2 lbs.	141 lbs.	+18 lbs.	1·95		80%	

TABLE VI.

U.4 Sub-Strain Trial—Fisher's Latin Square Layout.

Strain.	*Mean Yield of seed cotton per plot.*	*Equivalent yield per acre.*	*Diff. from Mixed Bulk.*	*Yields referred to mean of all plots as 100.*	*Criterion of Significance = 15·1%*	*Stand.*	*Remarks.*
U.4/Mixed Bulk	8.6 lbs.	391 lbs.	—	83·5%	All significantly heavier yielders than U.4 Mixed Bulk.	58%	4 Plots per treatment, plots 1/45·37 acres.
U.4/26	10.0 lbs.	455 lbs.	+64 lbs.	96·5%		62%	Fertilizer 200 lbs. supers plus 50 lbs. ammonium sulphate per acre; soil red loam. American bollworm attack very bad.
U.4/64	12.0 lbs.	545 lbs.	+154 lbs.	115·5%		72%	
U.4/130	11.0 lbs.	499 lbs.	+108 lbs.	106·0%		73%	

Nineteen U.4 sub-strains were grown in observation multiplications, but none appeared so promising as /64, and to a lesser extent, /26. /117 yielded fairly well when growing on land in which sunnhemp had been ploughed under the previous year, but the lint tended to be soft. In the same area /128 and /39 also yielded fairly well. Some further selections from the multiplication bulks were made.

*Special Bulk U.*4.—The Special Bulk U.4 issued to growers for multiplication this last season did well on the whole. Plots were well looked after and some very good yields were obtained, quite a number exceeding 1,000 lbs. seed cotton per acre with a very thin rate of seeding and wide spacing. The Special Bulk is undoubtedly intrinsically better in yielding power, uniformity of jassid resistance, and in lint quality, than the general U.4 Mixed Bulk, but it definitely is not as much better as some of the yields would appear to show. It was generally given priority in planting, on good land, and was better looked after than the ordinary cotton; being generally in a small isolated block, moreover, it did not usually suffer as heavily from bollworm attack as the bigger areas of Mixed Bulk. A considerable area will be commercially under U.4 Special Bulk this coming season.

Varieties Other than U.4.

No variety or strain other than U.4 gave satisfactory results. Observation plots were planted out to Cambodia, An.12, Z.1, and Bancroft selections; Durango, Punjab Americans, and Turkestan cottons. All failed in one way or another. The Cambodia selections, though excellent as regards jassid resistance and more moderate in

growth than the original Cambodia, were later than the U.4 lots, and with their big bolls suffered badly from bollworm. There is no alternative in sight to U.4 and the U.4 sub-strains. If for any reason U.4 or the selections from it could not be grown, very little cotton would be planted until something could be bred to replace it.

Spacing Trials.

Spacing trials were conducted on the Station and by a number of growers throughout the country, using the commercial U.4 Mixed Bulk. We are greatly indebted to the growers who have carried out trials, both spacing and fertiliser. The interesting results that are being obtained fully justify the labour involved. The results are definite, and markedly in favour of a closer spacing than that at present adopted. Six inches in the row, the closest spacing tried, gave the best results, not only where bollworm attack was severe, but on a rich farm at a low altitude where the bollworm attack was negligible. The style of growth of the 6-inch plots under these conditions appeared better than at the wider spacings.

A Harland trial, *i.e.*, with groups of plants in each line with spacings 1 inch to 30 inches, laid down more or less to see how it would work, and with flowering and bolling records for each spacing taken across the rows, showed results all in favour of the close spacings. As far as can be seen, the lint from the 6-inch plots was much the same in quality as that from the plots at the wider spacings, considering, of course, it was all Mixed Bulk, from which the lint is soft.

This coming season, growers in other districts are undertaking a further set of trials, using 12 replications instead of 8, with slightly smaller plots than last year. On the Station composite trials on the Fisher system will be laid down combining strain and spacing comparisons, so that some idea of the response of the different strain types to the different spacings may be obtained. No definite advice has been given to growers for this coming season. They have been informed of the results of the trials for last season, and it has been suggested that they should try at least a small proportion of their lands at a closer spacing, say 6 inches, even though they cannot lay down small plots for comparison. A number of growers in each district will lay down definite trials. At the same time, they have been warned of the possible dangers of close spacing—dangers which are, however, probably less likely to eventuate in Southern Rhodesia than, say, in the Barberton areas—bearing in mind the later planting dates in Rhodesia, and the necessity in most areas of setting an early crop.

Firstly, there is the possibility that closely spaced plants would not have the same powers of recovery from a serious early drought; from the rainfall figures available that does not appear to be so likely in the present cotton areas in Rhodesia as in some areas in the Union. Secondly, should a bollworm attack come earlier than it has done so far, say in early February, the more closely spaced plots might not have the same powers of recovery as those at a wider spacing. The attacks that are recorded hitherto have been in March and April: for such attacks a close spacing is a marked advantage. There is probably not the same chance of an early attack in a country under so much maize as, for example, at Barberton, where the typical attack seems to come from one brood which then passes on. Again, the recovery of a late crop after bollworm is to some extent problematical in many of the areas in Rhodesia, owing to the falling temperatures recorded in May in some seasons.

The early crop is undoubtedly the best and, among other ways of securing it, closer spacing should be especially useful, if the possible dangers mentioned above appear not too considerable: it is only by further observations and trials throughout the country, and over a number of years, that a more complete assessment of the advantages and disadvantages of close spacing will be possible. It will be necessary also to watch the effects on quality of the different spacings in the different seasons.

On the Station, flowering and bolling records were taken on scattered groups of plants, as in the record plots, for each intra-row spacing, 6 inches, 12 inches, 18 inches, 24 inches (spacing 4 feet between the rows) on equivalent areas: for example, at the 6-inch spacing, on 400 plants; 200 plants at the 12 inch-spacing; 133 at 18-inch, and 100 at 24-inch. The flowers and bolls per plant per day were reduced to a basis of 6-inch spacing. Similar records were taken on trials of one and two plants to a hole at 12-inch and 24-inch spacing, the results were then reduced to a basis of 12-inch spacing. (*See* Fig. 8.) The marked superiority of the closer spacing is shown, and the flowering curves for one plant per hill at 12-inch spacing, and two plants per hill at 24-inch, are interesting.

The final yields were poor, and only a fraction of the potential, even of that calculated from the actual flowering recorded. It has been suggested that had the flowering not been stopped by bollworm, the 24 inches spacing curve would have outstripped the 6 inches and given a larger final crop. In the Chipoli results this was not so. A heavy crop was set, markedly heavier at the closer spacing. A set of curves, using picking weights instead of boll numbers was made and they are very similar to the curves presented.

FIG. 8.

SPACING TRIALS. 1&2 PLANTS PER HILL: 12" & 24"

EQUAL AREA EACH SPACING
RESULTS REDUCED TO 12" BASIS.

BOLLING

BOLLS P.H.P.D.

1 AT 12". 1 AT 24".
2 AT 12". 2 AT 24".

FLOWERS P.H.P.D. SMOOTHED 5 DAY MEAN.

FLOWERING.

FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST

1 PLANT PER HILL: 6", 12", 18", & 24"

EQUAL AREA EACH SPACING
RESULTS REDUCED TO 6" BASIS.

BOLLING

BOLLS P.H.P.D.

1 AT 6". 1 AT 18".
1 AT 12". 1 AT 24".

FLOWERING

1930.

JAN. FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST

TABLE VII.

INTRA-ROW SPACING TRIALS—U.4 COTTON.

Centre.	*Trial Layout.*	*Spacing in the row.*	*Yield of seed cotton per plot.*	*Equivalent yield per acre.*	*Difference from 24″.*	*M. Diff. / S.D. of M. Diff. (= Z)*	*Significance.*	*Stand.*	*Remarks.*
			lbs.	lbs.					
Gatooma— (Cotton Station)	Half drill strip, plots 1/22·7 acres. 8 replications, but 12 of 12″ (Control) treatment. 4 ft. rows, 4 rows per plot.	6″	11	250	+140	2·3	High	80%	Soil red loam, maize the previous season. Fertilizer 250 lbs. supers plus 50 lbs. sulphate of ammonia per acre. Very bad American Bollworm attack.
		12″	8·0	182	+ 72	Control	—	86%	
		18″	5·9	134	+ 24	1·13	Low	87%	
		24″	4·8	110	—	2·9	High	90%	
Gatooma— (J. R. Hudson, Humewood)	Half drill strip, plots 1/30·25 acres 7 replications per treatment. 4 ft. rows.	6″	29	922	+194	—	Nil	—	Soil red loam, maize two previous seasons. Bad American bollworm attack.
		12″	29	922	+194	Control	—	—	
		24″	22·9	728	—	1·34	High	—	
Gatooma— (L. Henderson, Carfax)	Half drill strip, plots 1/34·6 acre. 8 replications per treatment. 3½ ft. rows.	6″	7·75	259	+203	1·9	High	Poor	Very bad American bollworm attack.
		12″	5·3	177	+121	Control	—	,,	
		24″	1·6	56	—	2·13	High	,,	
Salisbury— (Tobacco Station)	Originally half drill strip as above; 8 replications (see Remarks).	6″	1·6	1,059	+420	·65	Nil	V. Poor	Germination very bad, and plots reduced to 1/686 acres. Equivalent yields per acre high, but not significant.
		12″	1·1	738	+ 99	Control	—	,,	
		24″	0·9	639	—	·43	Nil	,,	
Mazoe— (J. M. Moubray, Chipoli)	Half drill strip, layout, plots 1/34·6 acre. 8 replications per treatment. 3½ ft. rows.	6″	37·2	1,262	+510	1·35	High	—	Almost free of bollworm. Type of growth, on good land, better at closer than wider spacing.
		12″	29·9	1,015	+263	Control	—	—	
		24″	22·1	752	—	1·87	High	—	
Sinoia— (W. A. Beattie, Dunphaile)	Half drill layout, plots 1/34·6 acre. 8 replications per treatment. 3½ ft. rows.	6″	9·3	316	+157	1·25	High	—	Good red loam. maize several years previously. Very bad American bollworm attack.
		12″	7·3	247	+ 88	Control	—	—	
		24″	4·7	159	—	3·07	High	—	

TABLE VIIA.

INTRA-ROW SPACING TRIAL—FISHER'S LATIN SQUARE LAYOUT.

Spacing in the Row.	*Mean yield of seed cotton per plot.*	*Equivalent yield per acre.*	*Difference from 24″ yield.*	*Referred to mean of all plots as 100.*	*Criterion of significance =19·7%.*	*Stand*	*Remarks.*
	lbs.	lbs.	lbs.				
6″	17·1	343	+155	131·5%	6″ Yield significantly higher than the others, and 12″ than the 2 last.	83%	Plots 1/20·2 acres, 6 rows per plot, 4 ft. between rows, 4 replications of each spacing. Soil red loam. Fertilizer 100 lbs. supers per acre. Previous crop Sunnhemp. American bollworm attack very bad.
12″	14·3	290	+102	111%		87%	
18″	11·0	222	+ 34	85%		87%	
24″	8·9	188	—	72%		92%	

TABLE VIII.

NUMBER OF PLANTS PER HILL TRIAL—U.4 COTTON.

Centre.	*Trial Layout.*	*No. of Plants per hill and spacing in the row.*	*Yield of seed cotton per plot. lbs.*	*Equivalent yield per acre.*	*Difference from 1/12″*	*M. Diff. / S.D. of M. Diff. (=Z).*	*Significance.*	*Stand.*	*Remarks.*
Gatooma— (Cotton Station)	Half drill strip, plots 1/22·7 acre. 8 replications per treatment, 4-ft. rows.	1/12″	7·5	170	—	Control	—	—	Fertilizer 200 lbs. supers and 50 lbs. ammonium sulphate per acre. Soil red loam. American bollworm attack very bad. Composition of average plot = 71 doubles, 18 singles, 11 blanks.
		2/12″	6·4	145	−25	0·48	Nil	89%	
		1/24″	4·0	91	−79	2·3	High	—	
		2/24″	5·3	120	−50	2·3	High	92%	

The results of the trials on the Station and in the districts are presented in Tables VII and VIIa. On the Station, plots were weighed line by line. No "neighbouring plot" effect was apparent. Line weights were analysed and there was no significant difference between the yields from the lines within the plots and from the lines bordering on the plots of different spacing. The stands were good: the percentage stands are given in the tables. Any blanks or irregularity of stand in the wide spaced plots would affect them more seriously than in the closer spaced plots. As in practice there is a continual loss of plants throughout the season, this is another very important point to be considered in favour of an initial close spacing. The importance of obtaining a good stand, if at all possible, is being impressed on growers. If the spacing results are to be equally applicable to other years, good, as contrasted with bad, stands, will make a very big difference to the yields obtained. This past year, seed was scarce, and only thin seeding rates were used. Very few growers had satisfactory stands.

Table VIII gives the results from a spacing trial, spacing one and two plants per hill at 12 inches and 24 inches.

An intra-row spacing trial, Table IX, was laid down, contrasting 4 feet spacing between the rows with 3 feet 3 inches spacing. The results are significantly in favour of 3 feet 3 inches. The yields per row are approximately the same, showing that the 4 feet spacing, under the conditions of the season, was too wide, the advantage of the plots at 3 feet 3 inches being in the greater number of rows per unit area.

TABLE IX.

Intra-Row Spacing Trials—U.4 Cotton.

Centre.	*Trial Layout.*	*Spacing between Rows.*	*Yield seed cotton per plot.*	*Equivalent yield per acre.*	*Difference from control.*	*M.Diff / S.D. of M.Diff (=Z).*	*Significance.*	*Stand.*	*Remarks.*
			lbs.						
Gatooma (Cotton Station)	Half drill strip plots 1/22·7 acres. 8 replications per treatment. 15″ in the row.	3′3″	8·0	183	—	—	—	74%	Soil, red loam: fertilizer 200 lbs. supers plus 50 lbs. sulphate of ammonia per acre. American bollworm attack very bad.
		4′	10·3	234	51	·92	Low	77%	

Fertiliser Trials.

Fertiliser trials were undertaken on the Station and by one or two farmers in other districts, using U.4 Mixed Bulk. The applications

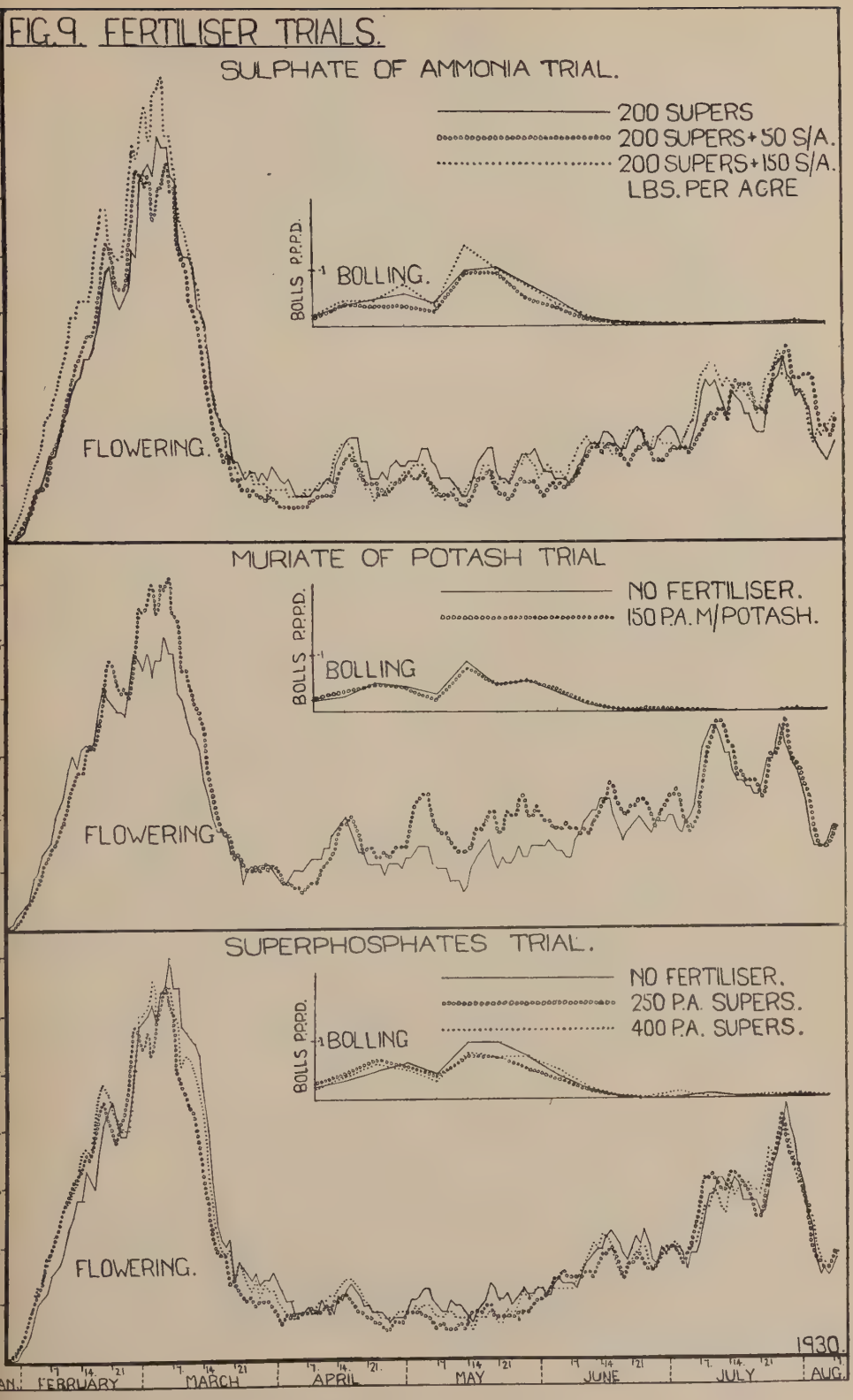
tested were of phosphates, potash, and the addition of sulphate of ammonia to a phosphate dressing. Records have been kept of previous crop and fertiliser applications. The results are indefinite; on the Station only very slight responses were recorded. In none of the trials were any differences between plots visible to the eye. The fertilisers were applied by hand to the rows before planting, and plots hand-harrowed. The application was thus a surface one. The results from the Tobacco Station, Salisbury, though from groups of plants in plots with a bad stand, and thus of doubtful significance, indicate the possible benefits on sand veld of a superphosphate application. Results from another farm in the Gatooma district show significant increases on the application of superphosphates and of potash. A farmer in the Lomagundi district unable to carry out trials, recorded no increase from a potassic superphosphate application, 150 lbs. per acre; nor when touring did one receive from farmers reports of benefit to their cotton crop by the direct application to it of fertilisers, as one does in the case of other crops.

Farmers are being urged to experiment for themselves with fertiliser applications, but in the meantime, rather to fertilise crops known to respond to direct application, and to plant cotton after them. Much more information is needed before recommendations can be made with confidence. The problem may be quite different on the sand veld, and may vary with different methods of application, for example, with fertiliser ploughed in, instead of applied to the surface. Further trials are being undertaken by growers in the districts, and for each trial, a record is obtained of the previous treatment of the land and crops grown.

Cotton on the Station grew well on land green manured with sunnhemp in the previous year, and repeatedly good crops with a healthy style of growth have been seen growing on land down to tobacco, fertilised, the previous year. This coming season on the Station, plots will be laid down to run for a year or two under varying fertiliser applications, combinations, and treatments.

Flowering and bolling records were made for each treatment, as in the other recording, and these are graphed in Fig. 9. The curves for the superphosphate plots are very similar to the curve for the control. Slight advantages from the application are apparent in the potash, and sulphate of ammonia plots; but they are only slight, contrasted with the more marked differences between the spacing curves. Again, curves were made using the weekly yields from the recorded groups of plants, instead of the boll numbers. The curves are very similar to those shown.

FIG. 9. FERTILISER TRIALS.



The results from the trials are given in Tables X, XI and XII. The final yields for the Station trials are very poor, but there is no evidence that the fertiliser applications helped the crop or assisted the formation of an early crop. The quality of the lint from all the trials appears much the same: the stands were good: lines were weighed separately. Again there is no evidence of "neighbouring plot" effect as might have been expected, owing to the roots of the line of the control adjoining the treated plots obtaining benefit, if there is any, from the treatment.

U.4. Sub-Strains—Seed Cotton and Lint Characters.

A general complaint about Rhodesian cotton this season has been the softness and lack of character of the lint. The possible seasonal causes of this have already been discussed. While most of the lots grown on the Station are on the soft side this season, some being distinctly soft, several show quite a moderate strength. /64 and the /64 re-selections are quite good, and /130 is good. Mr. Hesse of the Central Co-operative Cotton Exchange, Limited, Durban, in a note on lint bales from the Station, while commenting on the softness of the general Mixed Lots, stated that some of the cotton pulled beautifully, was excellent in strength and character, and was far superior to any other cotton that he had handled from Rhodesia.

Unfortunately, the lint of /26 appears to be rather on the weak side. A Special Bulk of /26 which appears slightly better is being multiplied. Most of the re-selections from the /26 multiplication bulk appear fair. /130 is a slightly better stapled cotton than the other families under multiplication. The lint of /64 is of good staple and uniformity, while /26 is possibly slightly longer but less regular. In ginning percentage, /64 is slightly lower than the run of lots—33%–35%—(bulk-ginned on the Station 50-saw power gin): /26 gins about 38%–38·5%, with some of the re-selections slightly lower: /130 gins about 36·5%: and /117 about 37·5%. The other good qualities of /64 are, however, more than sufficient to compensate for this slight loss in ginning percentage.

Broker's and Spinner's Reports on the Lint of the Season, 1928–29.

Samples of lint from the 1928–29 crop, U.4 Special Bulk, and from five single-plant lots were sent home for broker's report, spinning tests, and a report on the measurable characters of the lint. We are again indebted to Messrs. Wolstenholme and Holland, to the Shirley Institute and to the firms which carried out the spinning tests.

TABLE X.

SUPERPHOSPHATE TRIALS—U.4 COTTON.

Centre.	*Layout.*	*Treatment.*	*Yield seed cotton per plot in lbs.*	*Equivalent yield per acre.*	*Difference from control.*	*M. Diff. / S.D. of M. Diff. (=Z).*	*Significance.*	*Stand.*	*Remarks.*
Gatooma— (Cotton Station)	Half drill strip, plots 1/22·7 acre. 8 replications per treatment. Spacing 4 ft. × 15 in.	0	5·7	131	+10	·33	Nil	83%	Soil red loam, maize fertilized with 150 lbs. supers the previous year. Bollworm (American) attack very bad.
		150	5·3	121	—	control	—	80%	
		400	6·7	153	+32	1·83	high	85%	
Gatooma— (J. R. Hudson, Humewood)	Half drill strip, plots 1/30·25 acre. 6 replications per treatment. Spacing 4 ft. × 12 in.	0	14·8	471	—117	1·68	high	—	Red loam planted to maize the previous year and fertilized. American bollworm attack bad.
		100	18·6	588	—	control	—	—	
		300	19·6	625	+37	.66	Nil	—	
Salisbury— (Tobacco Station)	Half drill strip, as above (see Remarks).	0	0·73	365	—320	1·82	—	—	Stand so bad that results taken from 25 plants per plot only, and results, therefore, not significant.
		100	1·4	685	—	control	—	—	
		300	1·6	795	+110	1·03	—	—	

TABLE XI.

MURIATE OF POTASH TRIALS—U.4. COTTON.

Centre.	*Layout.*	*Treatment.*	*Yield seed cotton per plot. lbs.*	*Equivalent yield per acre.*	*Difference from control.*	*M. Diff. / S.D. of M. Diff. (=Z).*	*Significance.*	*Stand.*	*Remarks.*
Gatooma— (Cotton Station)	Half drill strip, plots 1/22·7 acre. 8 replications per treatment. Spacing 4 ft. × 15 in.	0	5·5	125	—	Control	—	86%	Soil, red loam. American bollworm attack very bad.
		150	6·3	143	+18	1·70	High	92%	
Gatooma— (J. R. Hudson, Humewood)	Half drill strip, plots 1/30·25 acre. 8 replications per treatment. Spacing 4 ft. × 12 in.	0	13·5	430	—	Control	—	—	Red soil, Maize for 2 seasons—the last season fertilized. This year 93 lbs. basic slag per acre. American bollworm attack bad.
		100	17·0	538	+108	1·59	High	—	

TABLE XII.

SULPHATE OF AMMONIA TRIAL—U.4 COTTON.

Centre.	*Layout.*	*Treatment.*	*Yield of seed cotton per plot. lbs.*	*Equivalent yield per acre.*	*Difference*	*M. Diff. / S.D. of M. Diff. (=Z).*	*Significance.*	*Stand.*	*Remarks.*
Gatooma— (Cotton Station)	Half drill strip, plots 1/22·7 acre. 8 replications per treatment. Spacing 4 ft. × 15in., 4 rows per plot.	0	7·2	163	24 lbs.	·68	Nil	91%	Soil, red loam. American bollworm attack very bad.
		50	8·25	187	—	control	—	91%	
		150	8·35	190	+3	—	—	86%	

The broker's report (Table XIII) is satisfactory. The lint from /64 and /130 is valued appreciably higher than the special bulk lint, which last year was an improvement on the general Mixed Bulk U.4 lint. Table XIV gives the spinning test results. The yarns were described as quite good: /64, /130, and the control were considered best with regard to levelness and freedom from nep. The remainder were described as appreciably inferior in appearance. The General Report states: "The behaviour throughout the mill was quite satisfactory, the waste losses being low and the spinning good. These cottons seem clean, and not particularly irregular." /26 was described as barely suitable for 42's twist. /64 and /130 gave medium quality yarns at 42's twist, and have probably reached the commercial limit at that count. /130 was the best.

TABLE XIII.

BROKER'S REPORT.

Cotton Sample.	*Grade and Remarks on Colour.*	*Length of Staple (Fractions of an inch).*	*Strength of Staple.*	*Quality and Character of Staple.*	*Nominal Valuation.*
U.4 Special Bulk	Strict good middling creamy colour.	Good $1\frac{1}{8}$" to full $1\frac{1}{8}$"	Weak to Medium.	Wanting in lustre and fineness.	9·75d.
U.4/26	Strict good middling creamy colour.	Full $1\frac{1}{8}$" mixed with short.	Medium	Wanting in lustre and fineness.	9·90d.
U.4/64	Strict good middling creamy colour.	$1\frac{3}{16}$" rather mixed with short.	Medium	Wanting in lustre and fineness.	10.40d.
U.4/130	Strict good middling creamy colour.	$1\frac{3}{16}$" rather mixed with short.	Medium	Wanting in lustre and fineness.	10.40d.
U.4/119	Strict good middling creamy colour.	Full $1\frac{1}{8}$" rather mixed with short.	Medium	Wanting in lustre and fineness.	9·90d.
U.4/123	Strict good middling creamy colour.	Full $1\frac{3}{16}$"	Medium to strong.	Fairly lustrous not very fine.	10.90d.

Based on American Futures—8·40d.
Based on Middling American—8·81d.

TABLE XIV.

SPINNERS' REPORT.

Cotton Sample.	*Nominal Counts. Type of Yarn Spun.*	*Twist Constant.*	*Total Waste %*	*Strength Tests.*			
				Lea Strength in lbs.	*Work of Rupture in inch lbs. per Lea.*		
					Mean.	*S.D.*	*Count × Strength.*
U.4 Special Bulk	42's Twist	3·9	10·2	Lea Strength	36·8	1·8	1626·6
				Work of Rupture	55·0	3·3	2431·0
				Actual Count	44·2	·7	—
U.4/26	42's Twist	3·9	10·5	Lea Strength	38·3	2·0	1708·2
				Work of Rupture	51·9	3·1	2314·7
				Actual Count	44·6	·8	—
U.4/64	42's Twist	3·9	10·5	Lea Strength	36·8	2·7	1637·6
				Work of Rupture	57·9	2·5	2576·6
				Actual Count	44·5	·7	—
U.4/130	42's Twist	3·9	9·9	Lea Strength	39·4	2·0	1713.9
				Work of Rupture	63·2	3·8	2749·2
				Actual Count	43·5	·8	—
U.4/119	42's Twist	3·9	10·4	Lea Strength	34·2	1·2	1501·4
				Work of Rupture	52·2	1·3	2291·6
				Actual Count	43·9	·6	—
U.4/123	42's Twist	3·9	10·1	Lea Strength	38·2	1·4	1696·1
				Work of Rupture	57·9	1·7	2570·8
				Actual Count	44·4	·7	—
Memphis (Control)	42's Twist	3·9	12·6	Lea Strength	38·9	1·6	1719·4
				Work of Rupture	59·1	1·7	2612·2
				Actual Count	44·2	·7	—

U.4. SINGLE PLANT LOTS AND RE-SELECTIONS.

There were in all 189 U.4 single-plant lots, and 19 selections from miscellaneous lots. The U.4 lots were planted at 4 feet by 3 feet, with 2–3 rows of plants at 15 inches, to get some idea of the behaviour of the lot at a possible commercial spacing. As much selfing as possible was done, concentrating, as the season advanced, on the more promising lots. To give some idea of the extent to which selfing was

possible, in the re-selections from /26/4, 75% of the material was selfed, in a single re-selection up to 90% : in /64/7, 62% of the material: and in /78/3, 83%. There was really only one picking, bollworm taking the second crop, and the low temperatures in June and July preventing the setting of a late crop. In the selfed material, the well-opened bolls were picked separately for the lint examination records. The percentage of well-opened bolls shown in Tables XV, XVI and XVII, considered in connection with the yields, is interesting, indicating to some extent the reaction of the lots to the seasonal conditions. Well-opened bolls were picked separately only from the selfed material, to which, therefore, these percentages relate. There is no reason, however, why they should not apply equally to the whole picking. /64/7 and /26/4 are outstandingly the two best lots, followed by /78/3 (Table XV). /64/7 grew out well, rather laxer than the /64 general type, with long, slightly spreading fruiting branches : it was a good clean opener, a good fruiter, and essentially a sympodial type. It appeared to have the power of setting and holding on to a good early crop this season, before the bollworm attack, and at the same time to be trying always to compensate, by further flowering, for the loss the bollworm had caused. Before picking it was a most spectacular lot compared with its neighbours. Two rows planted at 15 inches between the plants, for observation of the behaviour of the strain at a possible commercial spacing, yielded at the rate of 600–700 lbs. per acre. Mixed Bulk U.4 in trial plots near by was yielding around 125 lbs. per acre.

The lint is good, about 31 mm., fairly regular, and ginning out rather better than the ordinary /64. The lint, as with the rest of the /64 lint, is appreciably stronger, under the conditions of the season, than most of the U.4 lots grown. /26/4 is a completely different type, smaller, stocky, with close erect fruiting branches, short internodes, opening fully, but not as cleanly as /64/7—often with one or two erect vegetative branches, almost plants in themselves. Even more than /64/7, it had the power of setting quickly and holding on to the first crop. The lint is slightly longer than that of /64, but probably not quite so uniform, and appreciably softer. The ginning percentage is slightly higher, but not up to the general /26 standard. Rows at 15 inches spacing were yielding at a rate of over 700 lbs. per acre, and, with growth such as was obtained this year, /26/4 is probably a type which would repay closer spacing. Its most marked characteristic, contrasted with other lots and the general Mixed Bulk, was the proportion of the crop which had set before the height of the bollworm attack, and thus was " made."

TABLE XV.

Primary U.4 Selections.

Strain.	Weight per Plant.		% No. of well-opened bolls (Selfed material).	Ginning %			Lint Index.	Weight of 100 seeds.	Lint Length "Mean max" measurement	Baer Diagram.				Uniformity of Lint.		Lint Strength.
	Seed Cotton.	Lint.		On 300 Seeds.	On Total Picking.	On Plant Lot.				Mean. Coefficient of variation	Absolute max.	% No. of hairs included by "mean max" measurement	% No. of hairs under ½".	Butterflying 1–5	Length Range between pulls.	
	gms.	gms.					gms.	gms.	mms.	mms. %	mms.					
U.4/26/4/3	135·1	52·7	87%	39·6	39·0		5·3	8·0	30·8	21·9 ± 28	35·5	95	9	4+	Medium	Medium
4	158·6	56·5	76%	34·9	35·7		4·5	8·3	32·1	22.6 ± 30	36·5	94	14	4+	Wide	Strong
8	140·8	52·4	79%	36·8	37·2		5·3	9·1	32·6	22·6 ± 29	36·5	94	8	4–4+	Small	Medium
9	105·8	40·2	84%	39·0	38·0		5·3	8·3	31·5	23·6 ± 28	36·0	90	8	4	Widish	Medium
10	101·9	37·1	75%	37·0	36·6		4·5	7·7	31·0	19·8 ± 33	37·0	100	16	4	Medium	Medium+
Mean of Re-selections (12) of family	112·5	41·3	79%	36·7	36·7	35·3	5·1	8·8	31·6	22·4 ± 30	—	94	—	—	—	—
U.4/64/7/3	141·3	49·9	83%	36·4	35·4		5·3	9·3	31·8	20·8 ± 32	35·5	96	12	4+	Small	Medium+
4	142·8	49·9	82%	35·7	35·0		4·9	8·8	30·1	20·3 ± 32	34·5	94	16	4+	Medium	Medium+
5	116·4	50·9	86%	35·6	35·1		4·5	7·6	30·2	18·5 ± 30	34·0	98	15	4–4+	Medium	Medium+
6	138·9	49·0	66%	37·2	35·2		5·3	8·9	30·7	22·6 ± 31	36·0	92	12	4+	Small	Medium
10	139·9	48·7	87%	35·7	34·9		4·9	8·8	31·2	22·9 ± 28	38·0	90	11	4	Medium	Strong
Means of Re-selections (10) of family	126.9	45.9	76%	35.8	35·2	34·3	4·9	8·9	31·0	21·4 ± 31	—	93	—	—	—	—
U.4/78/3/3	84·8	31·0	50%	35·7	36·6		6·0	10·9	34·9	21·6 ± 31	36·5	96	10	4–5	Small	Medium
4	101·6	37·0	94%	36·7	37·0		5·5	9·5	32·1	20·3 ± 29	36·0	96	11	4	Medium	Medium
6	145·9	55·7	82%	38·1	38·3		5·4	8·7	30·5	20·8 ± 37	35·0	88	18	4	Medium	Medium
7	139·5	46·8	63%	37·4	35·8		5·9	10·0	29·3	23·4 ± 28	33·0	79	7	4	Medium	Medium
8	134·5	51·4	73%	39·1	38·2		6·1	9·5	31·9	21·1 ± 31	36·0	95	15	4+	Medium	Medium
Mean of Re-selections (9) of family.	116·8	43·0	74%	37·0	36·8	35·8	5·7	9·6	31·0	21·6 ± 32	—	90	—	—	—	—

TABLE XVI.

FURTHER GOOD FAMILIES.

Family.	*No. of Re-selections.*	MEANS OF RE-SELECTIONS.								*Remarks.*
		Weight per plant.		*% of well opened bolls (selfed material).*	*Ginning %*		*Lint Index.*	*Wt. of 100 seeds.*	*"Mean max" lint length measurement.*	
		Seed Cotton.	*Lint.*		*On 300 seeds.*	*On total picking.*				
		gms.	*gms.*					*gms.*	*mms.*	
U.4/33/1	5	98·7	37·9	73	37·6	37·4	6·1	9·8	30·6	Vigorous squat type, 1–3 erect vigorous veg. branches, stiff fruiting branches, internodes short.
U.4/64/10	5	92·5	30·8	73	33·6	33·2	5·1	10·3	31·8	Fairly spreading type, 1–2 lax veg. branches.
U.4/106/2	4	122·9	45·2	78	39·0	36·8	5·8	9·1	31·4	Very jassid resistant. Stiff erect type, 1–3 veg. branches.
U.4/106/3	4	126·7	45·7	66	38·5	36·2	6·2	9·9	32·7	Laxer, more indeterminate type than 106/2.
U.4/117/3	4	97·4	36·6	65	37·9	37.6	5·9	9·8	30·1	Spreading type, drooping fruiting branches, bolls opening well.

TABLE XVII.

NEW SELECTIONS FROM MULTIPLICATION BULKS OF U.4.

Strain.	Weight per Plant.		% No. of well-opened bolls.	Ginning %		Lint Index.	Weight of 100 seeds.	Lint Length "mean max" measurement	Baer Diagram.					Lint Uniformity.		Lint Strength.
	Seed Cotton.	Lint.		On 300 Seeds.	On Total Picking.				Mean.	Coefficient of variation	Absolute max.	% No. of Hairs included by "mean max" measurement.	% No. of Hairs under ½".	Butterflying 1–5	Length Range between pulls.	
	gms.	gms.				gms.	gms.	mms.	mms.	%	mms.					
U.4/26 A	98·0	38·7	53	40·6	39·5	5·1	7·5	29·5	—	—	—	—	—	3+	Medium	Weak
K	77·3	29·9	68	39·1	38·6	5·2	8·1	31·0	—	—	—	—	—	4	Medium	Strong
L	74·7	28·4	84	38·2	38.1	5·3	8·6	31·0	—	—	—	—	—	4	Medium	Weak
M	90·1	35·3	70	39·6	39·1	5·9	8·9	31·4	—	—	—	—	—	4+	Fairly Wide	Medium
Q	85·6	33·2	59	39·1	39·0	5·3	8·3	32·5	—	—	—	—	—	4	Medium	Medium
Mean of Selections (19) of family	94·4	39·2	67	38·4	38·1	5·3	8·5	31·2	—	—	—	—	—	—	—	—
U.4/64 A	92·1	30·7	92	33·2	33·3	5·1	10·3	32·6	24·9 ± 27		41·0	90	5	4+	Fairly wide	Weak
C	114·6	39·5	83	34·8	34·3	5·4	10·2	31·6	21·1 ± 30		32·5	99	15	4	Medium	Strong
J	90·6	34·1	66	38·0	37·6	5·5	9·0	29·1	21·4 ± 29		37·0	90	12	4	Medium	Weak
K	111·7	35·1	70	31·1	31·5	4·7	10·4	31·4	24·4 ± 26		36·5	86	5	4+	Medium	Strong
T	61·3	19·0	89	30·9	31·0	4·7	10·4	31·0	24·4 ± 27		38·0	87	7	4	Small	Strong
Mean of Selections (26) of family	98·3	34·0	74	34·4	34·4	5·3	10·1	30·9	—	—	—	—	—	—	—	—
U.4/130 A	75·7	25·8	73	33·5	34·1	5·0	9·9	36·9	25·2 ± 35		43·0	90	11	4–5	Medium	Medium
B	97·8	34·3	58	35·1	35·1	5·1	9·5	35·5	21·6 ± 36		40·5	96	18	4+	Fair	Medium
C	66·6	22·6	63	33·6	34·0	5·0	9·9	32·2	22·9 ± 32		35·5	89	12	4+	Medium	Medium
Mean of Selections (3) of family	80·0	27·6	65	34·1	34·4	5·1	9·8	34·9	23·1 ± 34		40	92	14	—	—	—

/78/3, while not as spectacular as /64/7 and 26/4, is a moderately compact, heavy-bearing strain of good length, uniformity, and ginning percentage.

In Table XVI are set out details of some of the better families from which re-selections have been taken. The /117 lots bore fairly well, but the opening was only fair and the lint inclined to be soft. /106/2 and /106/3 are distinct and interesting lots, heavy yielding but markedly butterflied—*see* Table XVIII. Re-selections were made in the other /64 and /26 lots grown. The /33/1 lot is a heavy fruiter, compact, almost semi-cluster, and has distinct possibilities.

Re-selections for staple were made in /99/2, the longest stapled lot of last year. Lint samples of every plant in the lot were taken to see what segregation in the length there would be, but these have not yet been examined.

In the multiplication bulks of /64, /26, and /130, further selections were made (Table XVII). The plant analyses of the best are excellent and from such favourable stocks some good lots should be obtained next year.

The experience of a difficult year enabled a large amount of material to be discarded with certainty. The better lots were outstanding; but a number of re-selections from medium lots with particular qualities will be kept going another season.

Six small U.4 lots from Barberton, /4/2, /4/4/2, C.15, C.28, Z.9 and Z.14, will be tried amongst the Gatooma lots next year. A quantity of U.4/4 has been obtained for an observation bulk and possibly for inclusion in a trial.

Lint Length.—Length was measured from lots pulled at random from the selfed well-opened material. Five initial measurements were made for each selection and an arbitrary figure allotted for "butterflying" (1–5 badly-butterflied to square-ended—a classification of the Halo type from non-uniform to uniform), and an index of the range in length from seed to seed, from pull to pull in the general length analyses, was entered. All the length measurements were made in the same way, all by the writer, from a pulled tuft measuring to what he considered the sharp edge of the halo. This length is what is called the "mean maximum" lint length in the tables.

With a number of the single plant re-selections, placed bolls were picked separately and the positions on the plant noted. The measurements of lint length for each boll show the range in length that may occur within one boll and from boll to boll on a single plant, and in material which would probably be taken in the one picking. All the material collected has not yet been examined, but information has

TABLE XVIII.

Lint Length Variation—Interesting Lots.

Plant.	Yield of seed cotton.	% of well opened bolls (selfed material)	Ginning %	"Mean Max" lint length measurement.	Baer Diagram.					Uniformity.		Strength (relative)	Remarks.
					Mean	Coef. of Var.	Absolute max.	% No. of hairs included by "mean max" measurement.	% No. of hairs below ½".	Butterflying 1—5.	Length range between pulls.		
	gms.			mms.	mms.		mms.						
U.4/106/2/1	107·0	90%	35·9	"about 30"	22·1	29%	34·5	90	9	1	Medium	Strong	Very short internodes, Close F. Branches, Stiff, erect.
2	130·3	65%	34·3	34·5	21·6	27%	35·0	100	8	2	Medium	Medium	More spreading, less erect longer F. Branches.
3	116·6	83%	38·4	32·0	21·1	34%	36·0	95	13	4 to 4+	Medium	Medium	Erect, stiffer.
4	137·3	73%	38·6	29·1	22·4	32%	37·0	79	11	1 to 4+	Medium	Strong	- - -
U.4/106/3/1	133·6	70%	34·7	34·0	21·1	38%	40·0	96	18	Fair	Slight	Medium	- - -
2	120·9	71%	36·6	32·2	—	—	—	—	—	4	Wide	Weak	Fairly slender. Indef. F. branches.
3	140·9	47%	36·8	32·7	21·4	35%	37·0	95	16	3	F. Big	Weak	Three even V. Branches. Stockier than 2.
4	111·2	75%	36·5	32·0	—	—	—	—	—	3	Medium	Strong	More like 106/2. Stocky, Close, F. Branches.

been obtained for the season from the examination of the placed bolls for eighteen re-selections in /106/2, /26/4 and /64/7. Unfortunately, the bolls were not dated, so their " period " can only be gauged from their position on the plant.

Speaking generally the first-formed bolls have shorter mean maximum lint lengths than the bolls in the middle " period," the mean maximum lint lengths again tending to be shorter, even in a year like this with only one picking, in the later bolls formed. The later bolls formed are on the higher fruiting branches or on the fifth to eighth nodes on the lower fruiting branches, or on a fruiting branch of a main vegetative branch. Repeatedly, where two or more bolls have been taken from a fruiting branch about the middle position, the earlier and later bolls tended to be the shorter. In /26/4/9 six bolls were taken from the fruiting branch at the tenth node. The mean maximum lint lengths were :—

10/1	27·0 mm.	10/4	30·6 mm.
10/2	28·6 mm.	10/5	31·6 mm.
10/3	30·4 mm.	10/7	29·8 mm.

Equivalent bolls on a higher fruiting branch, maturing at a later period, were longer for the first bolls of the branch, with the later ones shorter. The greater competition for the available food supply experienced by these later bolls can be understood, though that should not have been as marked this year as in most years : it will be interesting to contrast this year's results with the results of a year when bollworm damage is light and a full crop is set.

Table XIX sets out some of the results obtained. It will be seen that /64/7 appears more satisfactory than the other two lots : the " length ranges " in the lint of a single boll are small, the range in the boll mean lengths are small, and the standard deviations are small. In most plants the range over the big proportion of pulls is very small ; an odd pull or two in an early or later boll giving the appearance of a slightly wider range.

In /26/4 some single plants are good, and some not so good. In the single plants that are not so good there may be a range of from 30–34 mms. in the lint from a single boll, 27·6–32·6 mm. between the mean lengths of bolls in different positions on the same plant, and a complete range in the pulls for a single plant from 26–34 mm., 27–33 mm., and 28–34 mm. The standard deviations are higher than for /64/7. This in the main is not taking butterflying into consideration, merely the range in pull from boll to boll. Further irregularity should be caused by butterflying. All of these figures are " mean maximum " lint lengths.

TABLE XIX.

LINT LENGTH VARIATION DATA.

Strain.	*No. of seeds measured.*	*"Mean max." lint length ± Standard Deviation mms.*	*Range of lengths within bolls mms.*	*Range of lengths between bolls, means. mms.*	*Highest and lowest length in plant. mms.*
U.4/26/3/4	35	30·1 ± 1·09	30 — 32	29·2 — 31·8	28 — 32
4	45	31·7 ± 1.64	30 — 34	29·0 — 32·6	28 — 34
6	50	31·1 ± 1·03	31 — 32	27·6 — 32·6	27 — 33
U.4/64/7/1	20	30·6 ± ·85	30 — 32	29·8 — 31·0	29 — 31
2	20	32·0 ± ·81	30 — 33	31·4 — 33·0	30 — 34
3	40	31·8 ± ·99	31 — 34	30·2 — 34·2	30 — 35
5	45	30·5 ± ·93	30 — 32	28·8 — 33·0	28 — 33
6	40	30·0 ± ·88	29 — 31	28·4 — 31·2	28 — 32
U.4/106/2/1	25	30·3 ± 2·41	30 — 35	27·8 — 32·8	27 — 35
2	25	34·0 ± 2·20	35 — 39	33·6 — 37·2	30 — 39

/106/2 appears bad. It is a strain which in the first general lint examination was described as badly butterflied, and with a wide range from pull to pull. Within the lint, from a single boll, pulls may vary by as much as 4–5 mm., and the mean length between bolls of the same plant, but in different positions, may vary from 27·8–32·8 mm., and 33·6–37·2 mm., with a complete range in the pulls for a single plant of from 27–35 mm., and from 30–39 mm. The standard deviations are definitely higher than for /26/4 and /64/7. The irregularity caused by the butterflying—range of length in a single seed—is to a great extent over and above this.

A few locks were measured seed by seed. If any seeds showed a shorter " mean maximum " length, they were the last or second last seeds in the lock.

All three lots /64/7, /26/4, and /106/2 are heavy yielders, and under the conditions of this year set and held on to an early crop. It will be interesting to obtain reports on the lint from /106/2 and even to breed up a plant lot from the re-selection, apparently the most irregular in length, badly butterflied, and with a wide length range in the pulls, all the more so in view of the conflicting results obtained from the Baer Diagrams. Spinning reports should be useful compared with reports on hair characters from what seem to be the better lots sent home.

The position as regards the measurement of length, and length irregularity, is far from satisfactory. Families appear to inherit the same general type of halo. Butterflying tends to run in families. Particular families show a wide range in length within the material from a single plant, and others a relatively small range. Questions still outstanding are to what extent are these irregularities in length important in selection work ? To what extent do they lower the value of the cotton to the spinner, and to what extent would a plant breeder be justified in discarding a strain such as /106/2, good in many ways, but with his primary methods of measuring, butterflied, and with a wide range of lengths in the lint of the single plant ?

One point which does appear from closer examination of lint lengths is that finer methods of examination by the halo method would probably not be satisfactory with cotton from a country such as Southern Rhodesia, apart from the personal factor in the judging of the halo edge. A halo may be sharp, a cotton " square-ended," and yet a large proportion of shorter hairs be merged with the longer ; then again the variations in length from seed to seed of a single plant make the finer estimation probably of little additional value.

Baer Diagrams were made for all the single plant re-selections. The results obtained are interesting. In all, the position of the

" mean maximum " figure obtained in the general analysis was marked. In some strains 99–100% of the number of hairs in the diagram are included by the " mean maximum " figure, in others only 80%—probably sharp-edged as against more merging halos. There is a tendency for the " mean maximum " length to include a higher percentage of the hairs in the shorter strains than in the longer.

In Tables XV, XVII and XVIII, the mean for the Diagram is given, the co-efficient of variation, with the absolute maximum of the Diagram, the percentage number of hairs below $\frac{1}{2}$ inch. and the percentage number of hairs included by the " mean maximum " measurement. The figures by no means support the view of the lots arrived at in the general analysis. The Baer Diagrams show up some medium lots as quite long, and other lots which were recorded as long to be only medium.

In particular the diagrams appear to upset any ideas that might be formed about the regularity or irregularity of the lots. Square-ended strains with little range in the material, in the " mean maximum " measurement, have quite high co-efficients of variation. They probably contain a high proportion of short fibres obscured by the medium and longer, while butterflied strains, with apparently a big range from pull to pull, give quite good diagrams and moderate co-efficients of variation.

Lots such as /64/7 which seemed to be specially uniform gave no better diagrams than lots such as /106/2, as already described, with all appearances of irregularity. /106/2/1 and /106/2/2, for example, which have quite good Diagrams, appear on ordinary examination to be very badly butterflied and highly irregular. For a number of reasons the co-efficient of variation is probably not a satisfactory measure of the irregularity.

The Baer Diagram gives, probably, a truer judgment on the length characters of a cotton than the other length examinations which a plant breeder makes. After a simple preliminary measurement of length by the halo method, Baer Diagrams, or some equivalent method, appears necessary before any knowledge at all satisfactory of the length distributions can be obtained.

In Southern Rhodesia yielding power allied with medium quality, especially a fair strength, is at present of prime importance. In selection, therefore, no lot will be discarded, if otherwise good, merely because of butterflying, or apparent marked irregularity from boll to boll. Baer diagrams will be made for all lots, and an attempt made to correlate the data obtained with the reports on the lots from brokers and spinners. A few lots, interesting from the point of view of

uniformity, *e.g.*, apparently uniform with poorish Diagrams, or apparently irregular with moderately good Diagrams, will be included in the lots sent home for brokers' opinion, and spinning tests. The Diagrams for the season with the figures will be forwarded to the Shirley Institute for comment.

Strength.—Tests of strength were made by pulling and snapping: arbitrary determinations of this quality were entered—Strong, Medium, Weak—purely an arbitrary classification for the material of the year, separating the single plant lots and re-selections into strength groups. For the immediate present in Southern Rhodesia, the classification of strains into strong and soft classes for staple is probably more important than classifications into groups for length uniformity and irregularity. Consideration will have to be given to the possible tendering effect on the lint of the sun, and having regard also to the range in "mean maximum" lint lengths between bolls of different "periods," advice given to growers on the number of pickings believed to be economically sound.

A start was made with hair weight per cm. and hair breaking load determinations, immaturity tests, *i.e.*, the proportions of normal, thin-walled and dead hairs, for single plant re-selections from the stronger and weaker groups, to ascertain how these determinations were related to the arbitrary strength grouping, to the general feel and character of the cotton, to the brokers' and spinners' reports on the samples sent home, and all these to the general plant habit, under the particular conditions of the year. The work has not gone sufficiently far to justify any observation being made.

General.—On April 26th, the Station was visited officially by the Honourable the Premier, the Honourable the Treasurer, the Honourable the Minister of Agriculture, and Members of the Legislative Assembly.

Dr. Harland visited the Station in April. Amongst the visitors in May were Sir Frederick Keeble of Imperial Chemical Industries, and Mr. Christopher Turnor.

Mr. Foster and Sir James Currie, accompanied by Mr. Milligan and Mr. Parnell, reached the Station at the beginning of June. A Farmers' Day was held on the Station, and the local farmers held a dinner in Gatooma in honour of the visitors.

APPENDIX.

Rotation Crops.

In all, 68·7 acres were under cotton, 134 acres under maize, 65 acres under sunnhemp ploughed in, 6 acres under sunnhemp for seed, 5 acres

under ground nuts, just over 1 acre under sunflowers, and 29 acres of new land were broken up.

Portions of the maize crop were attacked by Army Worm (*Laphygma exempta*) in early January. The bad patches, and stretches of grass badly attacked around the lands were sprayed with sodium arsenite, destroying and thus preventing the spread of the Army Worm. A high degree of parasitism was apparent towards the end of the attack. The loss of maize on the Station was not great, the destroyed areas being replanted for ensiling, but large acreages of maize were lost in the district and throughout the country. This is the second year in succession that there has been a serious Army Worm attack. Cotton is not attacked. This, together with the serious losses which witch-weed (*Striga lutea*) is causing the farmer, is forcing him to realise more and more the potential necessity to him of cotton, if only reasonable yields are obtainable.

On the Station the maize averaged 10·9 bags (2,180 lbs.) per acre in spite of the two drought periods. The best land, growing after cotton, averaged 13·8 bags (3,760 lbs.) per acre. In planting maize with a planter, series of rows were run under different fertiliser treatments, really amounting to big scale drill strip trials. The results obtained were indefinite.

The Gatooma Spanish Bunch ground nuts were again tested against the Nyasaland Native grown last year. The mean yield for the Gatooma Spanish Bunch was 9 % greater than for the Nyasaland Native, which was statistically significant; corresponding yields per acre were 1,509 lbs. and 1,382 lbs.

The sunflowers yielded seed at the rate of 833 lbs. per acre. Next season a portion of land will be under sunflowers as a green manure crop.

65 acres were under sunnhemp and ploughed in as a green manure crop. Rock phosphate at the rate of 100 lbs. per acre was applied at the time of seeding, to be available for the crops of the coming season. The soil on the Station is lacking in humus and it is proposed to turn in each year an appreciable acreage of green manure crop. The growth of the cotton after sunnhemp ploughed in was satisfactory, and it will be interesting to see the type of growth the second season after the ploughing-in.

30 acres of new land, which had been broken up, but which had not yet borne a crop, were put under sunnhemp. Good growth was obtained. New land of this description on the Station is suitable for nothing else, and it will be seen how the land responds under crop this season—the first commercial crop the land has borne.

The acreage under sunnhemp for seed, including a portion of the new land, yielded at the rate of 500 lbs. to the acre.

1.—GOOD U.4 SINGLE PLANT SELECTION, 1927-28 SEASON—UNAFFECTED BY BOLLWORM. Cf. PHOTOGRAPHS 2, 3, & 4.

2.—U.4/64/7 RE-SELECTION—MIDDLE AND TOP CROP LOST THROUGH BOLLWORM.

3.—U.4/64/7 PLANTS SHOWING CROP SET.

4.—U.4/106/2 RE-SELECTION—BOTTOM CROP "MADE."

NORTHERN RHODESIA.

REPORT ON THE WORK ON COTTON AT THE RESEARCH STATION, MAZABUKA, SEASON 1929-30.

BY

A. G. BEBBINGTON AND W. ALLAN.

SUMMARY.

In spite of the delay in planting, the season started well but later conditions were somewhat unfavourable. From one point of view this was fortunate as it gave an opportunity of studying adverse factors which did not appear during 1928-29. The main characteristics of the season were absence of jassid and very severe damage from bollworm and stainer.

Selections.—The single plant lots were so severely damaged by bollworm and stainer that little further detailed selection could be carried out. New selections showed that coarse, medium-late to late maturing types similar to U.4/6 were giving both the best yield and better quality lint.

Variety Trial.—In this trial U.4 showed that it was considerably better than either A.12 or Z.1/9. The yield of U.4 being 304 lbs. of seed cotton per acre as against 112 lbs. and 137 lbs. from A.12 and Z.1/9 respectively.

Seed Distribution.—Sufficient seed of U.4 for five acres each was issued to twenty-one farmers, but only thirteen plots were finally picked.

The average yield was only 122 lbs. seed cotton per acre. This low figure may be attributed to extensive losses from bollworm and stainer attack, in many cases to poor cultivation, and also to unfavourable climatic conditions.

Bollworm.—Both *Chloridea obsoleta* and *Earias sp.* occurred, but the greater part of the extensive damage is attributed to the former. The distribution and extent of bollworm damage was studied. The extensive shedding of squares which occurred from March onwards was almost entirely due to bollworm, while some 50% of boll shedding may be attributed to this cause. In the first picking about 21% of locks were damaged by bollworm and some 10% of locks in the second picking. Later planted and later maturing plants suffered less damage from bollworm, these facts being in agreement with the observed distribution of *Chloridea* in the field.

Stainers.—Practically all internal boll rot was associated with insect punctures. It was shown that the Pentatomid *Callidea dregei* carried internal bollrot, but two species of *Dysdercus* are regarded as the most important vectors. The distribution of three species of *Dysdercus*, the extent of damage due to staining, and the possibility of control by means of seed traps and hand picking were studied. Seed trapping and hand-picking have proved of no practical value, a decrease in staining of only 10% being effected by the former method and 8% by the latter. In the case of an uncontrolled plot the percentage of locks stained was 38% and 33% for the first and second pickings respectively while it is probable that 50% of boll shedding may be attributed to insect puncturing.

Season.

The season has been one of an abnormal type so far as can be judged from the available records. The total rainfall for the year amounted to 22·03 inches which compares with an average of 32·36 inches as recorded at the Mazabuka Railway Station* over the past thirteen years.

No ploughing rains fell until the end of November, which occasioned delay in planting, and this was further retarded by heavy and continuous rain during the first three weeks of December. The early plantings made in this month had ideal conditions for growth, as hot and humid weather prevailed throughout the greater part. The later plantings suffered from lack of moisture towards the end of December and in early January, which led to very poor germination. Dry conditions continued throughout January culminating in a drought period of nineteen days in February. As a result, large acreages of early-planted maize in North Western Rhodesia suffered severely, and in some cases there was complete loss of the crop.

Growth of the cotton plants on the Research Station was retarded by these conditions, and it is possible that premature flowering was also caused. An improvement in conditions during March and early April was reflected in increased flowering. Late rains fell in April, however, and were responsible probably for some proportion of the large amount of staining in the first pickings. Towards the end of April temperatures fell rapidly and never recovered, which would appear to account in some measure for the lateness of the crop, pickings being a full month later than in the season 1928-29.

Jassid did not appear in any numbers on the plants until May, and remained for a very short period. Little damage was caused except

*The rain-gauge at the Railway Station is approximately three miles distant from the Research Station.

in the more susceptible varieties—Arizona and Durango. Bollworm appeared in large numbers in the latter part of March and April and destroyed a considerable proportion of the first picking. Stainer (*Dysdercus*) appeared in large numbers early in March and also caused a large percentage of staining in the first pickings.

Selections.

One hundred and twenty-five single plant lots were carried forward from the previous season. These included new selections from U.4, U.4/4, U.4/5, U.4/6, Cambodia and Z.1/9, together with a number of re-selections from the above strains of U.4. These were planted during the first week in December. All the seed was planted a single seed to each hole, at a spacing of 3 feet 6 inches by 3 feet 6 inches.

The germination was very good and the final stand excellent. The plants made very good growth during December, which was continued in January in spite of the dry conditions prevailing. Selfing was carried out throughout the season.

Stainer (*Dysdercus*) appeared in late February and caused serious damage to the young bolls throughout March, while in March and April the American bollworm destroyed a very large number of squares and bolls. This destruction of the major portion of the crop accompanied by late rains in April caused a very large vegetative growth, the plants running up to a height of five to six feet in many cases.

Further selection on this material proved exceedingly difficult. Many of the plants were carrying no more than five or six bolls, and even these in some cases contained only very badly stained cotton. As a result any selection from the point of view of yield or lint characters was practically impossible. It was finally decided to select out families as a whole. These were examined in so far as was possible for uniformity of type and their appearance as compared with their record for the previous season. Families showing good uniformity and close resemblance to their previous description were harvested as small bulks. Families which appeared in any way doubtful, but which had a past good record for lint and yield were included in a special bulk, while others were discarded. Finally, 34 families were carried forward as small bulks, 31 were discarded, while the remainder were harvested together as special bulks. No families were carried forward from U.4/4, C.8 or Z.1/9 all being included in special bulks.

Some indication of the extent of the damage caused by bollworm and stainer may be obtained from the following figures. These contain the highest and lowest yields obtained from selected families.

TABLE I.

Plant.	Yield per plant, 1928–29.	Final stand, 1929–30.	Total yield, 1929–30.	Yield per plant, 1929–30.
	grms.		*lbs.*	*grms.*
U.4/M.149/1	142·4	188	14·6	36·3
U.4/M.153/1	148·5	212	3·6	5·1

These selections were taken in the season 1928-29 with a bias towards early maturity. As a result of the losses described above and the figures obtained relating to attack by bollworm and stainer (pages 189, 193) it was considered advisable to obtain a number of types including medium and late maturing plants.

Selections were made from U.4 bulk grown on the Station, and on a neighbouring farm ; as well as from U.4/2, U.4/4 and U.4/6. In all, one hundred and seventy-three fresh selections were made, of which thirty-seven were discarded on laboratory examination, leaving one hundred and thirty-six to be carried forward in the coming season.

The plants obtained from U.4/4 and U.4/2 proved disappointing on examination, particularly those from the former strain, both lint and yield being of a low standard. Throughout this selection it was evident that strong, coarse, late-maturing types, similar to the main bulk of U.4/6, were producing both the best yield and better quality lint. Those plants obtained from U.4 bulk numbering fifty-eight in all were, in the main, types similar to U.4/6. Very few plants of the small, finer and early description could be selected, as their yields and lint quality compared very unfavourably with that of the former type.

A comparison of the average lint length and yield of the selections from U.4/2, U.4/4, and a comparable set from U.4/6 are given in the table below.

TABLE II.

Strain.	Lint length.	Average yield per plant.
	mms.	*grms.*
U.4/4	30·1	53·1
U.4/2	30·5	79·8
U.4/6	31·6	99·1

In addition, it may be stated that the general quality of the lint of the above U.4/6 selections was much superior to that of either of the other strains. Both U.4/4 and U.4/2, particularly the former, are earlier maturing and less vigorous than U.4/6.

It was not possible to collect numerical data concerning the bollworm attack of 1928-29, but observation showed it to be at its maximum in April which agrees with the present season. The

appearance during this season of *Dysdercus superstitiosus* (Fig. 5, page 184) in large numbers early in the season was unexpected and undoubtedly caused the loss of a large proportion of the early crop.

While it is still a question on which much further information is required, it may be stated that U.4/6 gave the best yield during the year 1928-29, and that the results so far obtained indicate to some extent that a later maturing, rather than an early maturing strain may assist in the solution of the problem. With this in view it is proposed during the coming season to carry out a trial of differently maturing strains, together with a " Time of Planting Experiment."

Variety Trial.

A variety trial including U.4, A.12, Z.1/9 on the half-strip method was undertaken. Twelve repetitions of each variety were planted in eight row plots, eighty feet in length. The two middle rows in every case were used for plant development records. The trial was planted early in December and an excellent stand was obtained. Growth records were taken on sixty plants of each variety. Measurements were made from the head of a six inch nail at the base of the plant to the tip of the apical bud, and were carried out weekly. Two hundred and forty plants of each variety were used for recording flowers and bolls (the latter figures being taken weekly). The curves of growth increments (Fig. 2) show the effect brought about by the exceedingly dry conditions prevailing in February. Unfortunately it was found necessary to discontinue these measurements early in the season on account of the figures becoming unreliable owing to damage to the apical buds by grasshoppers.

The flower curves show clearly the superiority of U.4 over the other two varieties. These curves are abnormal in type. The rainfall for the season was distributed into three periods of heavy rain, followed in each case by dry conditions. In comparison with last season, flowering started almost a month earlier, giving a small peak in February. This was probably induced by the high temperatures and large amount of sunshine at this point and may have been somewhat premature.

The depression throughout March is accompanied by a drop in temperatures, sunshine, and a rise in humidity, while the peak in April is accompanied by more favourable weather conditions for flowering (Fig. 1). The later portion of the curve is more indefinite, but temperatures in both May and June fell rapidly. The maximum peak of flowering reached during April is very low and it is significant that this point is coincident with the point of maximum attack by bollworm (Fig. 7, page 192) and also with maximum shedding (Table XIII).

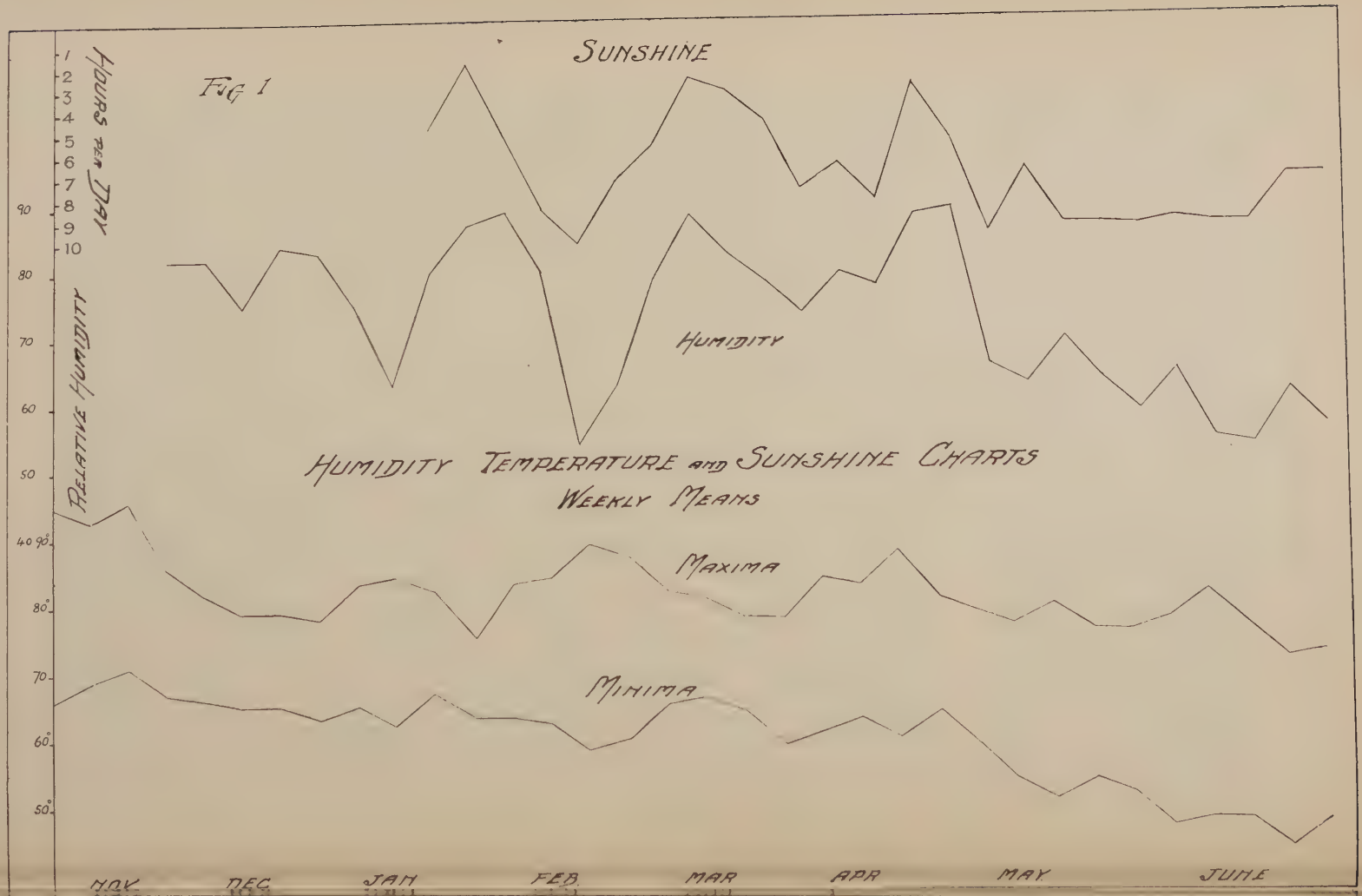


Fig 1
Sunshine
Hours per Day
1
2
3
4
5
6
7
8
9
10
Humidity
Relative Humidity
90
80
70
60
50
40
Humidity Temperature and Sunshine Charts
Weekly Means
Maxima
90°
80°
70
Minima
60°
50°
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE

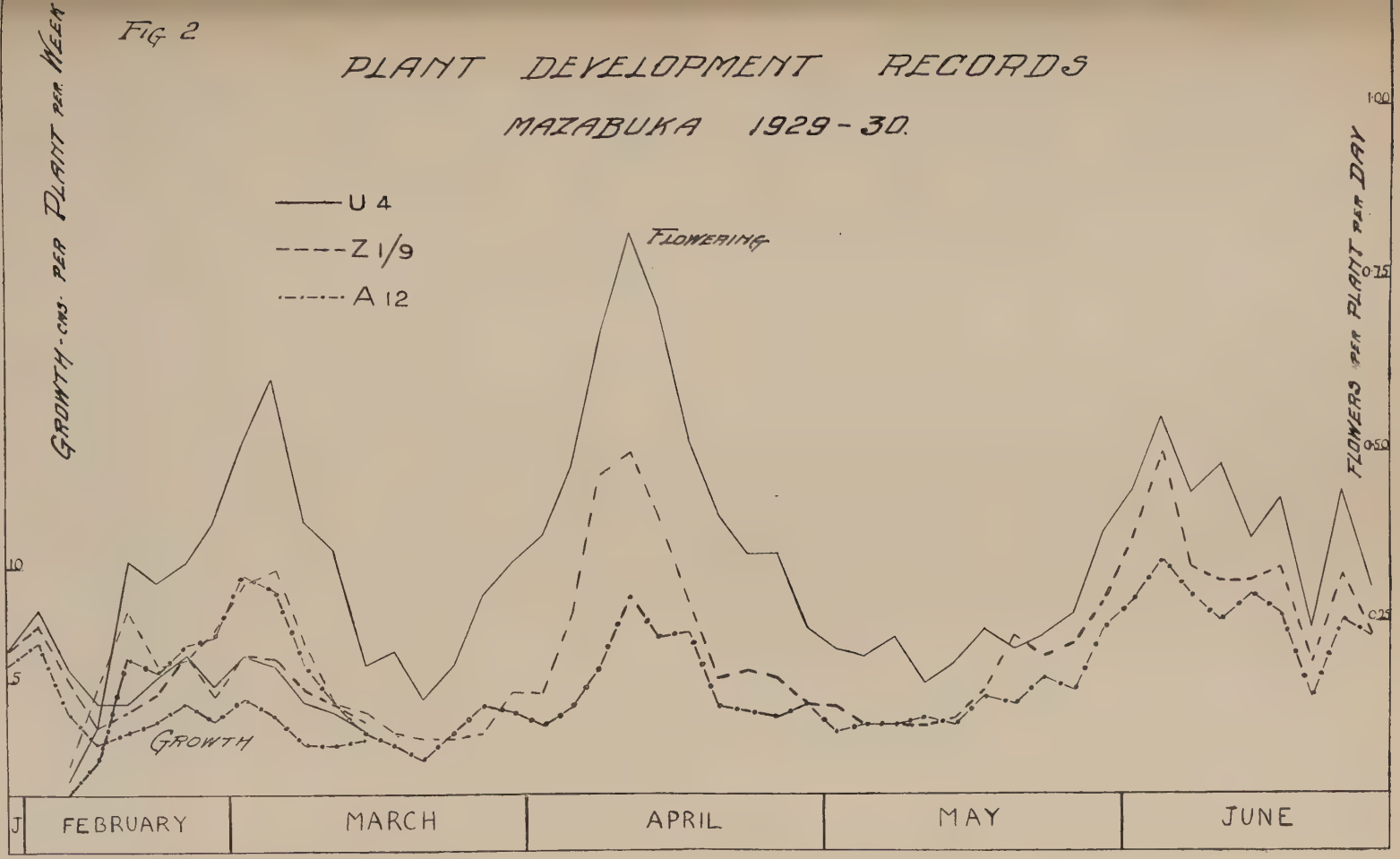


Fig 2
PLANT DEVELOPMENT RECORDS
MAZABUKA 1929-30.
U 4
Z 1/9
A 12
FLOWERING
GROWTH
GROWTH-CMS. PER PLANT PER WEEK
FLOWERS PER PLANT PER DAY
1·00
0·75
0·50
0·25
FEBRUARY
MARCH
APRIL
MAY
JUNE

The bolling curves (Figs. 3, 4) are a reflection of the flower curves, and further indicate the extent of the loss caused by the bollworm and stainer. Bolls were divided into good and bad classes at picking. The standard adopted was, if less than three locks contained good moderately clean cotton, the boll was considered bad. This method, while not entirely satisfactory, was the only one which could be employed.

It is of some interest that the flowering peaks in February and June took place immediately before an increase in the stainer population (Fig. 5, page 184). This would appear to be reflected in the fact that the proportion of bad bolls to good is much greater in the bolls resulting from these points of flowering, than in the case of the central peak, during and after which the stainer population was at a minimum. The unfavourable character of the weather during the season, may be gauged to some extent by the fact that although flowering commenced nearly a month earlier than in the 1928-29 season, the first picking was taken nearly a month later. Two pickings only were taken from this trial, and the final results indicate very clearly the significant superiority of U.4 over the other two varieties.

The final figures were :—

TABLE III.

Variety.	*Mean yield per acre seed cotton.*	*Difference from A.12.*	*Difference ÷ Standard error*
	lbs.	*lbs.*	
U.4	304	+192	8·5
A.12	112	—	—
Z.1	128	+16	1·2
		Difference from Z.1	
		lbs.	
U.4	336	199	9·3
Z.1	137		

Small Bulks.

Observation plots of one acre each of B.U.4/2, B.U.4/4, U.4/M.189 were grown for comparison with a similar plot of U.4 bulk. Flower counts and boll counts were carried out on these with a view to obtaining some information, and the further training of native assistants in this work. It was unfortunately impossible to compare the yields of these plots with that of U.4 bulk, as the latter was employed in the

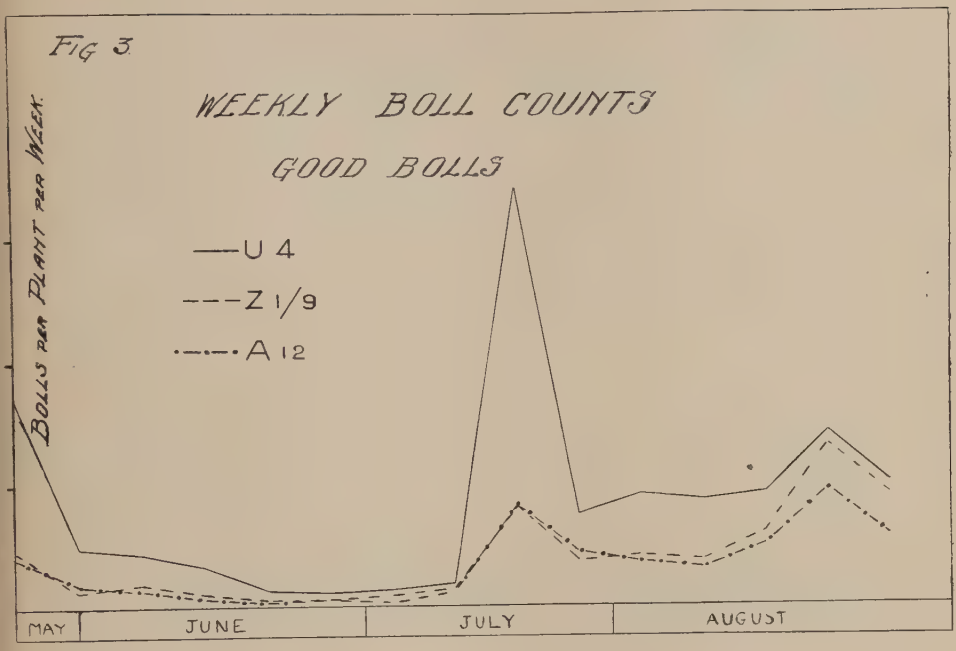


FIG 3.
WEEKLY BOLL COUNTS
GOOD BOLLS
BOLLS PER PLANT PER WEEK.
U 4
Z 1/9
A 12
MAY
JUNE
JULY
AUGUST

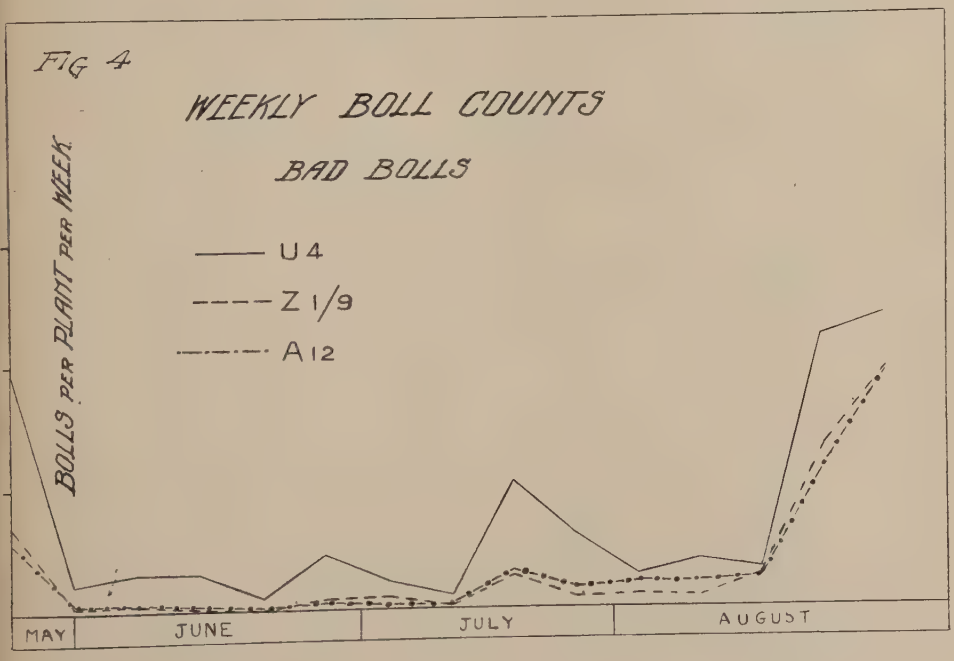


FIG 4
WEEKLY BOLL COUNTS
BAD BOLLS
BOLLS PER PLANT PER WEEK.
U 4
Z 1/9
A 12
MAY
JUNE
JULY
AUGUST

weekly counts of bollworm and stainer damage. The flower counts and boll counts which were carried out on these strains indicate the same results as were obtained in the variety trial records (Figs. 2, 3, 4). They show that strains producing an early flush of flowers did not produce any greater yield than those which set their crop later in the season.

The final crop produced by these strains was disappointing, particularly in the quality of lint. The majority of it was short and harsh, although quite strong.

The yields are appended in Table IV.

TABLE IV.

Strain.	*Seed cotton per acre in lbs.*	*Ginning %.*
U.4/M.189...	256	30·7
U.4/4	230	30·0
U.4/2	336	29·8

A trial of the above strains including U.4/6 and U.4 bulk will be carried out in the coming season.

Further small acreages of U.4, U.4/6, A.12, Z.1 9 and C.8 were planted as part of the rotation trials on the Station, also for multiplication and to provide seed for North Eastern Rhodesia. The yields are given in Table V.

TABLE V.

Variety.	*Acreage.*	*Yield, lbs. seed cotton per acre.*	*Remarks.*
1. U.4	3	449	Planted on some of the best soil on the Station.
2. A.12	4	83	
3. U.4	2	274	Field under rotation —cotton, maize, maize.
4. U.4/6	2	351	Field under a rotation—cotton, maize.
5. U.4/6	2	284	Field laid down to continuous cropping with cotton in 1927–28. Similar soil to Plots 3 and 4.
6. Z.1/9	4	190	Similar soil to Plot 1.
7. C.8	1	242	Same field as Z.1/9.

Plots bracketed together were either adjacent or on very similar soil.

Plot 1 of U.4 was used for the experiments in stainer control (see pages 185 to 188) and in view of the damage sustained from stainer and bollworm, the yield may be considered good. The poor yield of A.12 gives a striking verification of the results of the Variety Trial. The yields of U.4/6 compare very favourably with those of U.4 planted

on similar soil. A small plot of half an acre of Arizona was grown for purposes of comparison with resistant varieties. This yielded at the rate of 172 lbs. seed cotton per acre, which compares with 125 lbs. during the season 1928-29, and reflects the lower incidence of jassid during 1929-30.

Small Plots.

Small plots of the following strains were planted :—Z.106, Z.49/6, B.179, B.180, G.C.6A, G.C.8, and B.U.4/4/2.

All these strains will be discarded in the coming season with the exception of U4/4/2, which it is hoped to include in a Variety Trial with other strains of U.4.

Seed Distribution.

Sufficient seed of U.4 bulk to plant five acres by planter was distributed among twenty-one farmers in November, 1929. The plots covered the farming area of Monze, Mazabuka and Lusaka, together with a single plot near Livingstone. Two plots were not planted, and six were abandoned during the season, that near Livingstone being killed out by frost early in May. All plots, with the exception of two not easy of access, were visited twice or three times during the season. The results, with the exception of two, were very disappointing. The yield figures are given in Table VI.

The low yield may be attributed to various causes. There is no doubt that stainer and bollworm were responsible to a large extent for the poor yield. Other factors which may possibly be included are adverse climatic conditions, and also in many cases poor cultivation of the crop during the early stages, and the dry period in February.

TABLE VI.

Plot District.	*Acreage.*	*Total yield, seed cotton, in lbs.*	*Yield per acre seed cotton, in lbs.*
1. Mazabuka	5	359	71
2. ,, ...	15	2,457	163
3. ,, ...	5	1,200	240
4. ,, ...	5	898	179
5. ,, ...	5	418	83
6. ,, ...	5	306	61
7. ,, ...	5	112	22
8. ,, ...	5	220	44
9. ,, ...	5	1,281	256
10. Lusaka	5	803	160
11. ,, ...	5	199	39
12. ,, ...	5	382	76
13. Monze	5	508	101
Totals	75	9,143	—

Average yield per acre=122 lbs. seed cotton.

The crop was ginned in October, the ginning percentage working out at 31%. Samples of the nine bales of lint were submitted to the Central Cotton Co-operative Exchange, Durban, for grading. The grades obtained were :

3 Bales Good Middling : fair staple : good colour.
4 „ Good Middling : fair staple : very lightly spotted.
2 „ Strict Middling : fair staple : yellow spotted.

Mr. Hesse reported that " The cleanliness and the colour of the cotton are on the whole very nice indeed, and the staple though on the short side, is materially better in character than recent crops." It is significant that the three best bales were produced by the two keenest growers and by the Research Station.

For the coming season, seed for the planting of five acres each has been issued to twenty-six farmers. These plots will cover practically the same area as this season.

Pests and Diseases.

It will be obvious from the foregoing part of the report that stainer and bollworm have very seriously affected the yield and quality of the crop, while jassid has been a factor of negligible importance. That this would be so was apparent early in the season and so far as possible entomological work was concentrated on these two pests.

Bacterial Boll Rot and Angular Leaf Spot.

It was observed during the 1928-29 season, in which heavy rainfall was experienced during the early months, that a certain small proportion of the internal boll-rot was associated with external lesions closely resembling those caused by infection with *Bacterium malvacearum*. Angular leaf spot was prevalent among the plants in the early part of the season. In consequence, a rough trial with U.4 was carried out in the present season in order to find whether the incidence of this type of boll-rot was decreased by treatment of the seed with sulphuric acid in the ordinary way and with mercuric chloride (1/1000) for 10 minutes.

The incidence of angular leaf spot and of the suspected bacterial boll-rot has been so low during the season under review that the experiment failed in its main object. The only results which emerge are :

(1) The expected increase in rapidity of germination and in the final germination percentage, of the sulphuric acid-treated seed.

(2) A decrease in the incidence of angular leaf spot among the plants grown from seed treated with sulphuric acid and mercuric chloride.

The following table shows percentage germination of treated and untreated seed at 5-day intervals, both in the laboratory and in the field. The figures for germination in the laboratory are founded on 100 seeds of each variant while counts in the field are based in each case on 5 samples of 328 seeds each.

TABLE VII.

GERMINATION OF COTTON SEED.

	Percentage germination at 5-day intervals in the laboratory.			*Percentage germination at 5-day intervals in the field.*		
Days.	5	10	*Final stand.*	5	10	*Final stand.*
Acid treated seed	86	91	91	77	78	77
Mercuric chloride treated...	38	70	75	62	68	68
Untreated seed	48	70	72	62	65	64

A count on 100 plants of each of the three variants was made during the period February 3rd–13th, at what was judged to be the period of maximum infection with angular leaf spot. The following table gives the actual number of leaves infected with angular leaf spot on 100 plants of each variant.

TABLE VIII.

INCIDENCE OF ANGULAR LEAF SPOT.

Treatment of seed.	*Number of leaves infected with angular leaf spot.*
Sulphuric acid (Conc.)	16
Mercuric chloride (1/1,000)	20
None (Control)	197

Weekly growing measurements were carried out on 50 plants of each variant, but no significant differences in the growth of plants from treated and untreated seed is apparent, nor has there been any appreciable effect of treatment on the final yield.

Staining Associated with Insect Punctures.

In the course of an investigation of internal boll-rots during the present season considerably more than 30,000 bolls have been examined at various stages of maturity, and in practically every case the internal rot has been associated with proliferations caused by the puncturing of the boll by sucking insects. These proliferations for the most part resembled those described by Pomeroy for *Dysdercus*. The association has been so marked as to leave no room for doubt that during the season under review sucking insects have been the only factor of importance in the spread of internal boll-rot.

The Species concerned in the Spread of Internal Boll-rots.

The three species of *Dysdercus*—*D. fasciatus*, Sign, *D. superstitiosus*, F. and *D. intermedius*, Dist.—have again been the most prevalent sucking insects associated with cotton, both on the experimental station and on the small plots grown by farmers in the Western district.

The Pentatomid *Callidea dregei*, Germ, was again commonly observed feeding on bolls and the suspected association of this species with internal boll-rot led to a brief preliminary experiment to determine whether the insect actually transmits the boll-rot.

Three plants were stripped of all bolls, sprayed to remove any sucking insects, and covered with large insect-proof field cages. When the plants had again set an adequate number of bolls *C. dregei* was introduced into two of the cages as follows :—

Cage 1.—Twelve insects were caught in the field and introduced at once into the cage.

Cage 2.—Twelve insects were caught and fed on rotted bolls for three days before being introduced into the cage.

Cage 3.—No insects were put into this cage and it was examined each day in order as far as possible to prevent insects gaining admittance.

The insects remained in the cages for a period of three weeks after which all bolls were removed from the plants and examined. The results of this examination are shown in the following table :—

TABLE IX.

Association of C. Dregei with Internal Boll-rot.

Cage No.	*No. of locks examined.*	*No. of locks stained.*	*No. of locks more than half rotted.*	*Average No. insect punctures per lock.*
1. *C. dregei*	35	22	5	3·0
2. *C. dregei* fed on rotted bolls	40	30	15	4·0
3. (Control)	36	3	1	0·4

At the time when the bolls were removed a well grown nymph of *Dysdercus* which had apparently entered the cage through the netting at an early stage was found in cage No. 3 (Control), and to this cause apparently, the staining is to be attributed. In cages 1 and 2 no sucking insects other than *C. dregei* were found. It is noteworthy that in all cases staining was very definitely associated with the insect punctures while of the 60 locks bearing insect punctures 5 only showed no sign of stain. Thus it is clearly indicated that *C. dregei* is capable of transmitting internal boll-rot of cotton, but the extent to which it does so in the field is not yet determined. Seed traps have no attraction whatever for this species. It is however certain that, at least on the

Experimental Station, *Dysdercus fasciatus*, Sign. and *D. superstitiousus* F. are the most important factors in the spread of the internal rots.

The Seasonal Distribution of Dysdercus Spp.

The attempt to obtain a reliable figure for the seasonal distribution of the three species of *Dysdercus* was carried out on a block of U.4 cotton, 2 acres in extent, containing 32 rows and adjacent to the bulks of cotton on which other work was being done. Stainers from four rows only ($\frac{1}{4}$ of an acre) were picked each week and thus the normal distribution was disturbed as little as possible. The stainers collected were placed in tins containing paraffin and water and conveyed to the laboratory where a count was made of the number of each sex of each species, and the total number of nymphs. The results for adults of the three species are expressed graphically (Fig. 5) for the period March 5th–July 31st. It must be noted that in this graph the numbers of *D. superstitiosus* and *D. intermedius* have been plotted on a scale twice as great as that used for *D. fasciatus*. Counts are being continued in order to determine whether *Dysdercus* will breed on cotton throughout the winter and spring months. A rapid decrease in the stainer population of the plot throughout September was recorded, followed by the complete disappearance of nymphs and adults of all species during the second week of October. A considerable number of green bolls were present on the plants at this time.

It is not proposed to discuss in this report the implications of the distribution curve but merely to indicate the salient points wherein it differs from the distribution observed during the 1928-29 season. All three species have occurred in much greater numbers in the present season with a consequent increase in staining.

The most striking difference is the early influx of *D. superstitiosus* which was present on volunteer cotton late in December, and the occurrence of this species in the field in very large numbers, during March and April. Breeding experiments indicate that the peaks during March and April are caused by migration of adults into the cotton. Nymphs of *D. superstitiosus* first appear late in April and attain maturity early in June. That the increased staining experienced may be largely attributed to *D. superstitiosus* is indicated by a study of the distribution of this type of injury throughout the season.

Distribution of Staining.

The distribution of damage due to stainer and boll-worm throughout the season was roughly obtained by stripping all squares and bolls from 100 plants each week and making an examination in the laboratory.

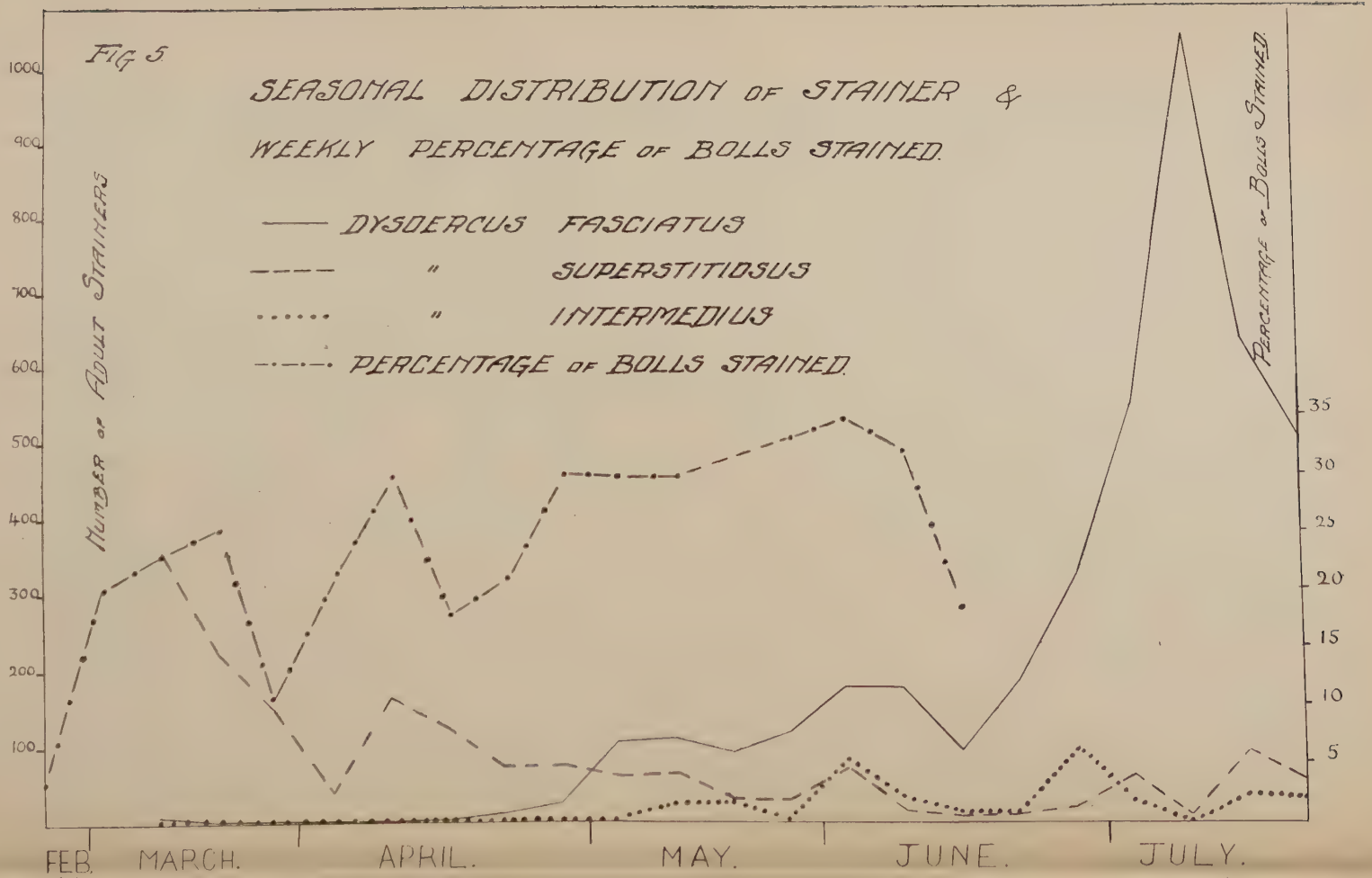


FIG 5
SEASONAL DISTRIBUTION OF STAINER &
WEEKLY PERCENTAGE OF BOLLS STAINED.
—— DYSDERCUS FASCIATUS
---- " SUPERSTITIOSUS
..... " INTERMEDIUS
-·-·- PERCENTAGE OF BOLLS STAINED.
NUMBER OF ADULT STAINERS
PERCENTAGE OF BOLLS STAINED
1000
900
800
700
600
500
400
300
200
100
35
30
25
20
15
10
5
FEB.
MARCH.
APRIL.
MAY.
JUNE.
JULY.

The figures obtained from these counts expressed as a percentage of stained bolls are graphed (Fig. 5). The two peaks of staining during March and April, corresponding apparently with the influx peaks of *Dysdercus superstitiosus* are noteworthy. The apparent decrease in degree of staining on June 16th is largely due to the fact that the opened bolls were disregarded in the count.

Control of Cotton Stainers.

Endeavours to control *Dysdercus* by means of crushed cotton seed and by hand picking were continued.

The main object has been the solution of the fundamental question whether the stainer population can be reduced by either of these means to the point at which an economic reduction in the loss caused by these insects results. An effort has also been made to solve subsidiary problems, such as the duration of attractiveness of seed traps, the relative value of crushed and uncrushed seed, the effect of moistening traps and means of increasing their efficacy.

During the work carried out in the 1928-29 season it was indicated that the efficacy of traps was increased by placing the seed on sheets of metal. This was explained by a tendency on the part of nymphs of the final instar to congregate under these sheets while undergoing the final moult. This point was given further attention in the present study.

An isolated 2-acre block of U.4 was used for the purpose of testing traps and hand-picking. Eighty traps were laid down over one acre. Of these 40 were placed on the ground and 40 on sheets of metal. Of each type of trap twenty were moistened each day. The layout of the traps is shown in the following diagram :—

X		y		X		y		X		y		X		y	
	x		Y		x		Y		x		Y		x		Y
Y		x		Y		x		Y		x		Y		x	
	y		X		y		X		y		X		y		X
y		X		y		X		y		X		y		X	
	Y		x		Y		x		Y		x		Y		x
x		Y		x		Y		x		Y		x		Y	
	X		y		X		y		X		y		X		y
X		y		X		y		X		y		X		y	
	x		Y		x		Y		x		Y		x		Y

X Traps of moist crushed cotton seed on metal.
x Traps of dry crushed cotton seed on metal.
y Traps of moist crushed cotton seed on ground.
Y Traps of dry crushed cotton seed on ground.

Stainers were collected from the traps daily and a count was made in the laboratory, records being taken of the numbers caught on each individual trap, both adults and nymphs. The remaining acre of the block was hand-picked daily. The gross totals of adult stainers caught in each type of trap are shown for each month during which trapping was carried out.

TABLE X.

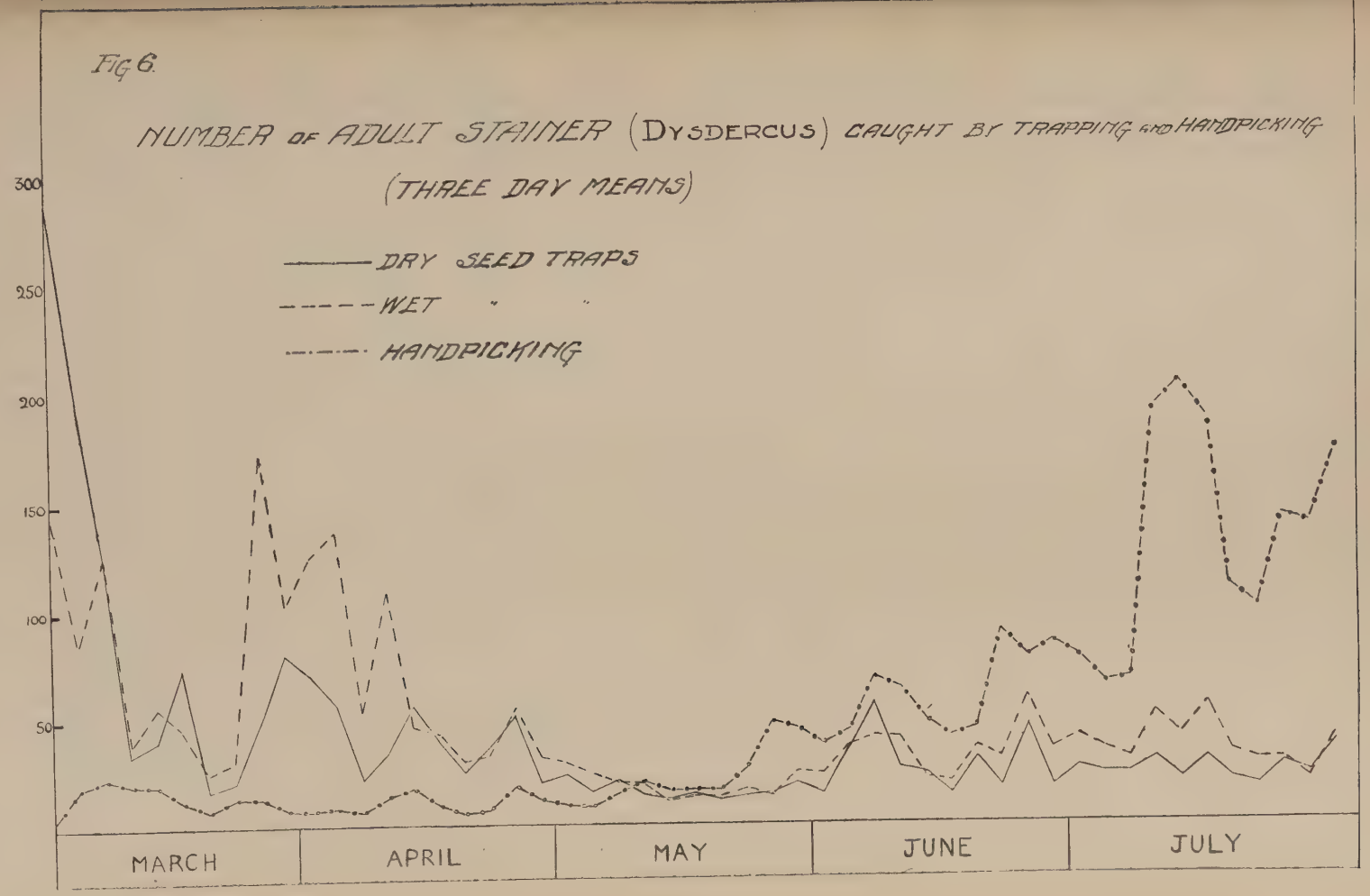
TOTAL NUMBER OF ADULT STAINERS CAUGHT BY SEED TRAPS AND BY HAND-PICKING.

	Dry traps.		*Moist traps.*		*Total traps (1 acre).*	*Hand-picking (1 acre).*
	On ground.	*On metal.*	*On ground.*	*On metal.*		
March ...	2,788	2,866	2,034	1,856	9,544	1,673
April ...	154	192	185	231	762	1,146
May... ...	162	81	189	170	602	2,908
June ...	366	299	393	404	1,462	7,508
July... ...	479	555	533	672	2,239	16,945
	3,949	3,993	3,334	3,333	14,609	30,180

An examination of the figures for the number of each species taken on the traps shows that the numbers of any one species expressed as a percentage of the total catch corresponds very closely with the actual percentage of the species present in the field at the same time. Under similar conditions, therefore the traps are equally attractive to each of the three species. The examination of the figures for sex-ratio have not yet been completed. Inspection of the figures indicates that no material advantage has been gained by placing the traps on metal, at least until the month of July, by which time any reduction of the stainer population can have little or no effect on the final loss. Daily catches from moist and dry traps are given in Fig. 6, expressed as three-day averages of totals from all traps. The daily figures of stainers hand-picked from half an acre are reproduced on the same graph. The information which has been gained is briefly summarised : –

(*a*) *The traps are effective only for a very limited period* extending in the present case from the beginning of March to the second week of April. At that point the plants themselves become more attractive than the traps. (This point was verified by hand-picking the trapped area during June and July when large numbers of *Dysdercus* comparable with the population of an undisturbed area were taken.)

Fig 6.


NUMBER OF ADULT STAINER (DYSDERCUS) CAUGHT BY TRAPPING AND HANDPICKING
(THREE DAY MEANS)
DRY SEED TRAPS
WET "
HANDPICKING
300
250
200
150
100
50
MARCH
APRIL
MAY
JUNE
JULY

It follows therefore that only the population of *D. superstitiosus* was materially affected, the population of *D. fasciatus* remaining practically normal.

(*b*) There is no advantage to be gained by moistening the traps during the period of rainfall since the addition of water merely hastens the rotting of the crushed seed and leads to a rapid loss of attractiveness.

During the short period extending from the cessation of the rains until the loss of efficacy of the traps catches may be materially increased by the addition of water.

After the point at which the plants become more attractive than the traps the increased catches on the moist traps are of no significance.

(*c*) Although an imposing number of stainers may be removed by hand-picking these consist largely of *D. fasciatus* captured in the latter part of the season when the species is very numerous in the field. The reduction of the population at this time is of little value.

Time has not been available for the completion of an analysis of the figures obtained from the comparison of crushed and uncrushed seed as traps or for the duration of efficiency of individual traps.

The Fundamental Value of Seed Trapping.

In order to determine whether any reduction in staining had been effected by seed trapping and hand picking of *Dysdercus spp.* the following procedure was adopted :—

Thirty random samples each of 10 plants scattered throughout the field were drawn from the area over which seed trapping had been carried out and thirty similar samples were taken from the hand-picked area. In the same way thirty random samples were taken on a field of U.4 on which the stainer population had not been interfered with in any way. It should be noted that this field was rather less than a quarter of a mile distant from the first field. In each case complete opened bolls were removed from the sample plants and examined in the field, a record of the number of locks showing staining associated with insect punctures, locks damaged by bollworm, and other types of injury being kept. No attempt was made to differentiate degrees of staining owing to the difficulty of fixing reliable standards. Two pickings were taken in each case.

In the following table the number of stained locks is expressed as a percentage of all locks examined. The count is based on a total of 14,251 bolls.

TABLE XI.

Analysis of Damage Due to Staining.

Method of stainer control.	*Date of picking.*		*Percentage of stained locks.*			
			1st picking.		*2nd picking.*	
	1st.	*2nd.*	%	*Standard error.*	%	*Standard error.*
1. Seed traps ...	30/6–1/7/30	12–13/8/30	28·8	±1·5	46·8	±1·7
2. Hand-picking	1–2/7/30	13–14/8/30	30·5	±1·3	43·3	±0·9
3. None	2/7/30	5/8/30	38·2	±1·5	32·6	±0·9

The comparison of conditions in fields removed some distance from each other is not an ideal measure, but no other means of obtaining an indication of the value of trapping appeared to be available and the field used as a control was that most closely adjacent to the trapped area which could be put to the purpose.

The thirty samples of ten plants appeared to give a reliable analysis of actual conditions in the field.

Using the equation

$$\epsilon_{12}{}^2 = \frac{\sigma_1{}^2}{n_1} + \frac{\sigma_2{}^2}{n_2}$$

(Engledow & Yule. "Principles and Practice of Yield Trials," page 10.)

we find that the standard error of the difference between the means of (1) and (3) for the first pickings is 2·1 while the actual difference between the two means is 9·4. $\frac{9{\cdot}4}{2{\cdot}1} = 4{\cdot}5$

The standard error of the difference between the means of (2) and (3) for the first pickings is 2·0 while the actual difference between the means (2) and (3) is 7·7. $\frac{7{\cdot}7}{2{\cdot}0} = 3{\cdot}8$.

Though by intensive trapping a decrease in staining of 9% and by hand-picking a decrease of 8% have been obtained, both of which border on statistical significance, the increased value of the crop is very far from commensurate with the cost of these operations. Furthermore these measures were carried out with a degree of efficiency which could never be approached by the commercial grower. The effect of the loss of efficacy of the traps is clearly indicated by the very high percentage of staining in the second picking. In the second pickings the standard

error of the difference between the means (1) and (3) is 1·9 while the actual difference is 14·2. $\frac{14{\cdot}2}{1{\cdot}9}=7{\cdot}5$.

The standard error of the difference between the means (2) and (3) for the second picking is 1·3 while the actual difference is 10·7. $\frac{10{\cdot}7}{1{\cdot}3}=8{\cdot}2$.

Thus there would appear to be a statistically significant increase in the amount of staining in the second-picking, both on the area on which seed trapping was carried out and on the hand-picked area. This result is at least partially accounted for by the better growth of the plants on these plots and the greater crop which they carried, conditions much more suited to the increase of stainer than those obtaining on the uncontrolled area.

It is unfortunately clear that, under conditions such as those of the present season, seed trapping as a commercial measure is of no value in controlling *Dysdercus spp.*, while hand-picking is equally ineffective. It is possible that under conditions of less intense infestation, trapping throughout the short effective period followed by hand-picking during the first period of influx of *Dysdercus fasciatus* may be of some value and it is proposed further to investigate this possibility.

Natural Enemies.

In the present season the Reduviid *Phonoctonus principalis*, Grst. was again observed to prey on *Dysdercus* and it was shown that the nymphs of *Phonoctonus* also prey on the nymphs of *Dysdercus* to which they bear a striking superficial resemblance.

The Reduviid appeared in such small numbers as to be a negligible factor in control.

Wild Host Plants.

A search for wild host plants of *Dysdercus* has been made during the season. Nymphs and adults have been taken on *Hibiscus cannabinus* adjacent to cotton, and occasional adults have been taken on *Thespesia sp.* So far as present observations go the most important alternative host plant is the baobab (*Andansonia digitata*).

Searches were carried out in an area wherein the baobab is a predominant vegetative type and removed about 15 miles from the nearest cotton. *Dysdercus fasciatus* was found feeding on fallen seeds of the baobab in very large numbers in the month of September. The species appeared to be breeding freely on the seed, nymphs were present and

many adults were found *in coitu*. A further visit to this district was paid on November 15th, after the disappearance of stainer from the observation cotton plot and *D. fasciatus* was found in even greater numbers feeding on the fallen seeds. The baobab was then in flower. It is of interest to note that only *D. fasciatus* was found, while of a large collection of nymphs taken from baobab seed and reared in the laboratory all that attained maturity were of this species.

Bollworm.

Bollworm has again accounted for a very considerable proportion of the crop. Though no actual records of bollworm damage were kept during the 1928-29 season, it may definitely be stated that the loss due to this cause was much less than that experienced in the present season.

The Spiny Bollworm (*Earias sp.*) appeared early in the fields, boring in the growing tips of the plants, before the setting of the first squares.

Eggs of the American Bollworm (*Chloridea obsoleta*) were laid on the plants early in March, the first larvæ being found in squares and bolls towards the middle of that month. Larvæ of *Chloridea* was found in bolls taken in the field until the end of the third week of April, by which time practically all had pupated, and no fresh outbreak occurred. The period of bollworm activity in the crop and its cessation late in April is illustrated graphically in Fig. 7. This figure is based on the weekly examination of all squares and bolls from 100 plants, the degree of damage being expressed as the percentage of bolls and squares damaged by bollworm.

The Spiny bollworm, apparently, does not disappear from the plants in April, but continues to breed throughout the year and larvæ of various stages of growth have been found in the seed pods of Okra (*Hibiscus esculentus*) during September and November, while adults have been bred out in the laboratory during October. This species appears to be a pest of relatively little economic importance and undoubtedly the greater part of the bollworm injury is to be attributed to *Chloridea obsoleta*.

The final damage due to bollworm, irrespective of the loss caused by shedding of bolls and squares which remains to be discussed, was obtained during the counts of bolls injured by stainer for the three fields on which these were carried out. The estimate is therefore based on three sets of thirty samples each of ten plants or 14,251 bolls both for the first and second pickings.

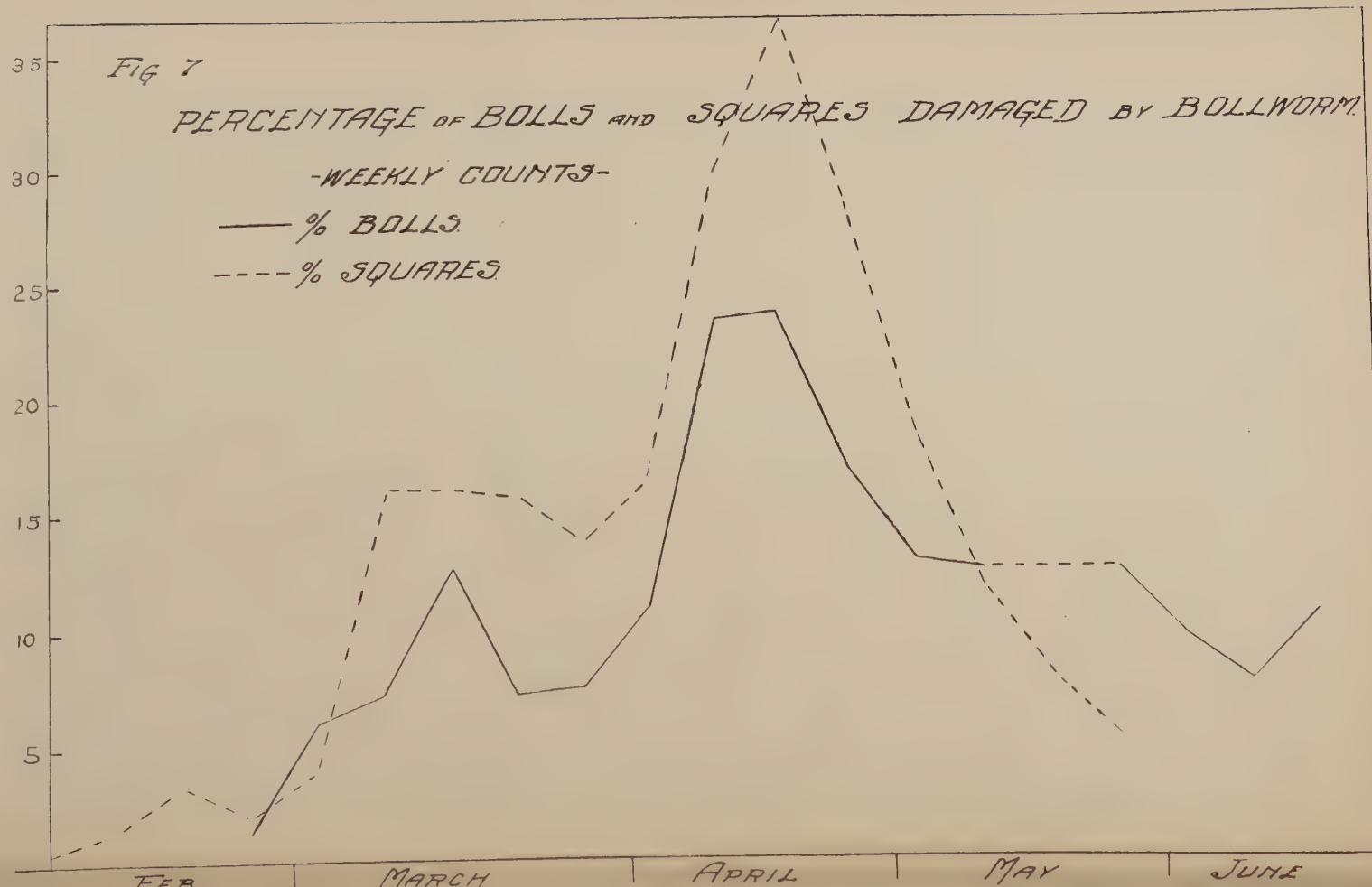


FIG 7
PERCENTAGE OF BOLLS AND SQUARES DAMAGED BY BOLLWORM
-WEEKLY COUNTS-
% BOLLS
% SQUARES
35
30
25
20
15
10
5
FEB
MARCH
APRIL
MAY
JUNE

TABLE XII.

Analysis of Damage Due to Bollworm.

Plot No.	Date of Picking.		Locks Damaged by Bollworm.			
			1st picking.		2nd picking.	
	1st.	2nd.	%	Standard error.	%	Standard error.
1	30/6–1/7/30	12–13/8/30	21·4	±1·4	8·5	±·75
2	1–2/7/30	13–14/8/30	19·0	±1·04	8·0	±·90
3	2/7/30	5/8/30	22·3	±1·8	12·1	±·92

Again using the equation $\epsilon_{12}^2 = \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}$ the standard errors of the differences of the mean percentage bollworm damage in the first and second pickings are as follows :—

Plot No.	S.E. of Difference of means.	Difference of means.	Difference S.E.
1	1·6	12·9	8·1
2	1·4	11·0	7·9
3	2·0	10·2	5·1

The comparatively low damage by bollworm to the second pickings is in accordance with the observed distribution of *C. obsoleta* during the season.

No accurate figure for the maturation period of the boll has yet been arrived at, but the bolls constituting the first pickings would presumably be set before the end of April and would therefore be on the plants during the period of bollworm activity. A considerable number of bolls constituting the second picking would be set after the period of intense bollworm attack with the consequent reduction in the amount of damage. It would seem that if the observed distribution is a normal one a partial solution of the bollworm problem is to be sought either in late planting or in the selection of a suitable maturing strain. The problem is bound up with climatic considerations, and is by no means simple. Reference to the flower-count curves (Fig. 2) shows that the maximum setting of flowers corresponds with the period of maximum bollworm infestation, a correlation which accounts for the severe loss caused by the pest.

Shedding of Squares and Bolls.

Severe shedding of squares and bolls has been experienced throughout the season. It was desired to obtain an indication of the major causes of this shedding, and no time being available for the more accurate method of ticketing squares, the following method was adopted.

From one row of a hundred plants, the squares and bolls shed during each day were collected from the ground, and examined in the laboratory. The monthly totals are tabulated.

TABLE XIII.

Month.	*Average No. of Squares shed per plant per month.*	*% shedding due to bollworm.*	*% Squares showing other injury.*	*% apparently healthy.*
February	1	59	11	30
March	5	89	5	6
April	10	95	2	3
May	3	90	3	7

The shedding of squares is largely attributable to bollworm.

TABLE XIV.

Month.	*Average No. of squares shed per Plant.*	*% shedding due to bollworm.*	*% Bolls showing other injury.*	*% apparently healthy.*
March	4	47	51	2
April	8	62	36	2
May	8	55	38	7
June	4	31	63	6

The damage described as " other injury " consisted of two types :

(1) A large number of newly set bolls, so small that it was difficult, and often impossible to determine whether they had been punctured by sucking insects. It is probable that a certain amount of this shedding was caused by stainer puncturing. Pomeroy states that " young bolls may be shed owing to mechanical action of stainer puncturing. One puncture is sufficient to obtain this effect."

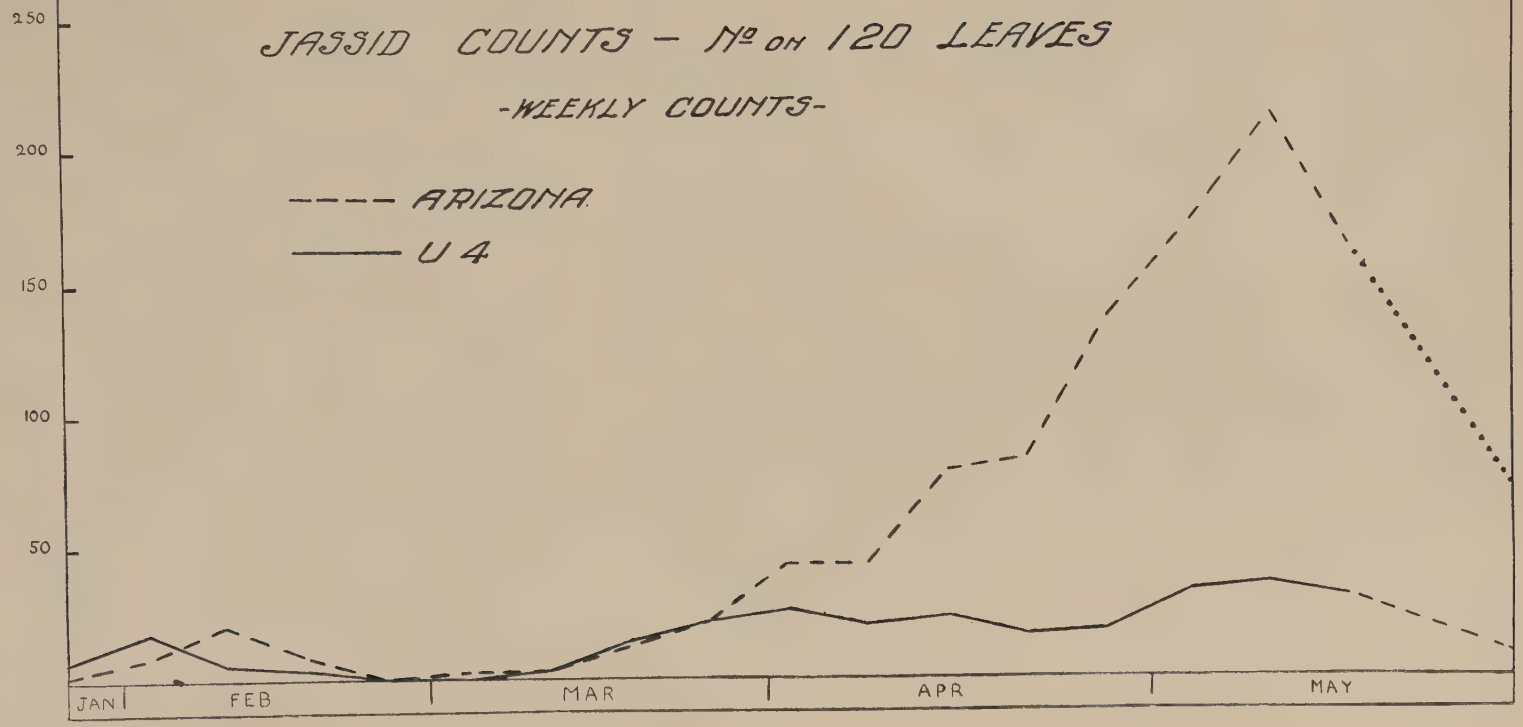
(2) A smaller number of more mature bolls bearing a very large number of insect punctures, usually badly rotted and presumably shed from this cause.

It would therefore appear that the extensive shedding of bolls have been due largely to insect injury.

Jassid (*Empoasca fascialis*).

In the season under review, jassid was late in appearing in the field, and never attained serious proportions, except in the case of the more susceptible varieties, and the yield even of these varieties was higher than during the previous season. Weekly counts of nymphs were carried out on the following varieties : U.4, A.12, Z.1, Arizona

Fig 8.


JASSID COUNTS — No ON 120 LEAVES
-WEEKLY COUNTS-
ARIZONA
U 4
250
200
150
100
50
JAN
FEB
MAR
APR
MAY

and several selected strains of U.4. The counts for U.4 and Arizona are given in Fig. 8. Under the conditions of the last two years U.4 and its derivatives have proved sufficiently jassid resistant.

Aphis (*Aphis gossypii*).

Fairly severe aphis infestation was experienced in the early part of the year. Strong colonies were established in January and the infestation reached its maximum in February. A steadily maintained falling off of infestation throughout March was followed by a slight increase of the pest during April. As last season, the aphis colonies gradually diminished throughout May, and the pest had practically disappeared from the plants by the end of that month.

The precise economic importance of the aphis is difficult to estimate, but the experience of the last two seasons would indicate that varieties differ to a considerable extent in their liability to severe infestation, and there would appear to be some measure of correlation between jassid resistance and aphis susceptibility.

It is difficult to assign a reason for the extremely poor performance of A.12 other than the heavy aphis infestation from which it has suffered. The infestation on U.4 and its derivatives was less severe, but it is probable that the plants suffered a check during February. The natural enemies recorded in the last report again appeared but considerably earlier, and in larger numbers. In addition the *Chilomenes lunata*, which was the only Coccinellid noted during last season, and *Exochomus auritus* also appeared on the plants in considerable numbers.

Minor Pests.

The destruction of seed in the ground was attributed largely to the cricket *Liogryllus bimaculatus*. A small leaf-eating beetle of the family *Galercucidæ* (*Exora apicipenne* Jac) appeared in large numbers on the plants in the cotyledon stage, and caused some damage.

The grasshoppers *Zonocerus elegans* and *Cyrtacanthacris aeruginosa* damaged the plants to some extent by eating leaves and growing tips.

A small weevil appeared in large numbers on the plants during January. It has been identified as *Labotrachelus incallidus* and apparently is not responsible for any injury.

It was noted that the sheets of metal on which seed traps were placed afforded very attractive hiding places for the cricket *Liogryllus bimaculatus* and for the ground beetles *Macropoda reticularis*, *Anchophthalmus plicipennis* and *Hister hottentottus*. Large numbers of the crickets and of the beetles could be collected from beneath the sheets.

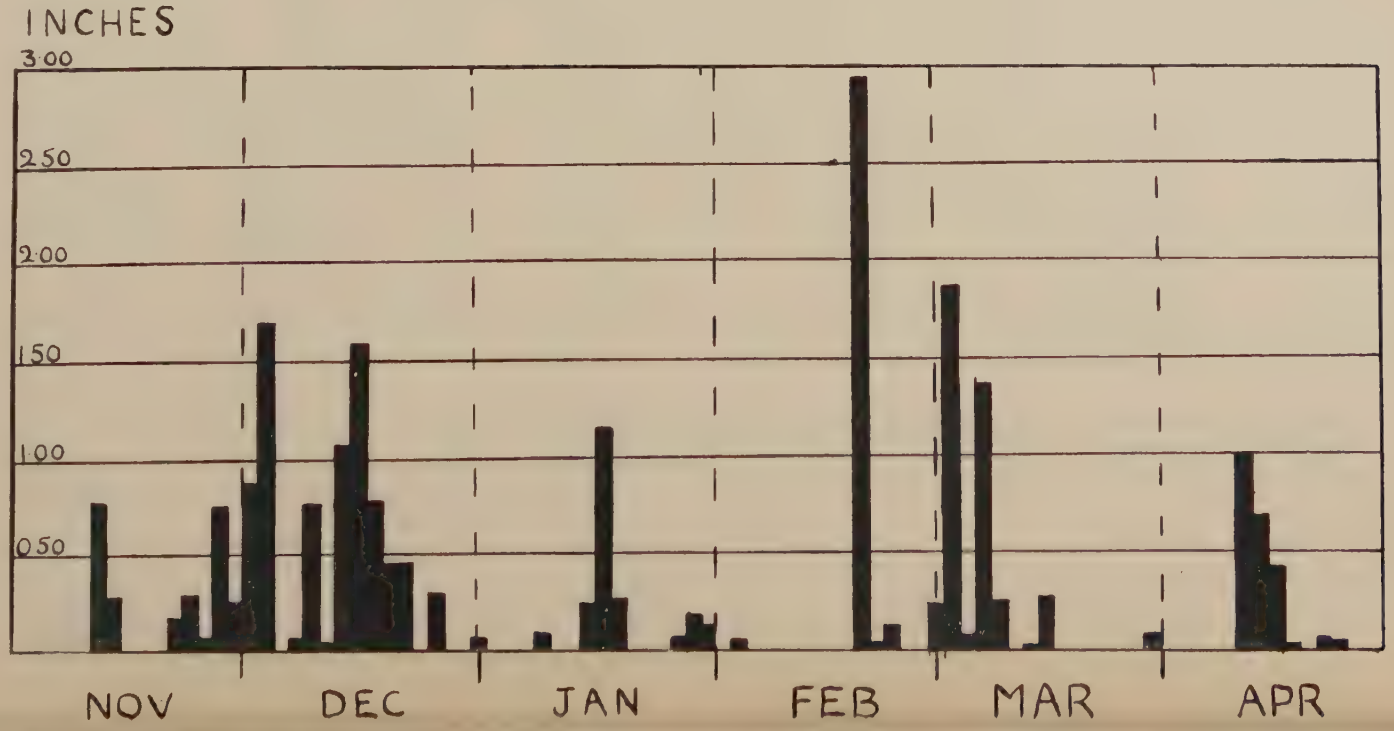
MAZABUKA RESEARCH STATION.
DAILY RAINFALL.
SEASON 1929-30.

	Nov.	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*
1 ...	—	0·74	0·04	Tr.	0·09	—	—
2 ...	—	0·13	—	—	0·15	—	—
3 ...	—	1·43	—	0·04	1·56	—	—
4 ...	—	0·26	—	—	0·33	—	—
5 ...	—	—	—	Tr.	0·04	—	—
6 ...	—	—	—	—	0·02	—	—
7 ...	—	—	—	—	1·21	—	—
8 ...	—	0·04	—	—	0·16	—	—
9 ...	—	0·35	0·07	—	0·23	—	0·01
10 ...	—	0·40	Tr.	—	—	0·45	—
11 ...	0·30	—	—	—	Tr.	0·55	—
12 ...	0·44	0·03	Tr.	—	Tr.	0·10	—
13 ...	0·26	0·41	—	—	0·01	0·58	—
14 ...	—	0·65	—	—	—	0·05	—
15 ...	—	0·98	0·24	—	0·28	0·37	—
16 ...	—	0·60	0·79	—	—	—	—
17 ...	—	0·76	0·34	—	—	0·01	—
18 ...	—	0·01	0·24	—	—	—	—
19 ...	—	0·19	0·04	2·91	—	—	—
20 ...	—	0·26	Tr.	0·03	—	—	—
21 ...	0·08	0·45	Tr.	—	—	0·05	—
22 ...	0·07	—	—	0·03	—	0·04	—
23 ...	—	—	—	0·11	—	—	—
24 ...	0·27	—	—	—	—	—	—
25 ...	0·02	0·16	—	Tr.	—	—	—
26 ...	0·04	0·14	—	—	—	—	—
27 ...	0·73	—	0·04	—	Tr.	—	—
28 ...	—	—	0·01	—	Tr.	—	—
29 ...	0·03	—	0·17	—	Tr.	—	—
30 ...	0·21	—	—	—	0·09	—	—
31 ...	—	—	0·11	—	—	—	—
Totals ...	2·45	7·99	2·09	3·12	4·17	2·20	0·01

Total Rainfall for Season = 22·03 inches.
No rain recorded June-October inclusive.

RAINFALL - MAZABUKA, 1929-30.

IN 2-DAY TOTALS



ANGLO-EGYPTIAN SUDAN

REPORT ON THE WORK ON COTTON CARRIED OUT BY THE PLANT BREEDING SECTION, DEPARTMENT OF AGRICULTURE AND FORESTS, SEASON 1929-30*

BY
M. A. BAILEY.

PART I.—SUMMARY.

The yields obtained at Shambat this season were very satisfactory. The average yield per feddan for cottons of Egyptian and similar type was just under four Kantars†, American cottons giving still higher returns.

This circumstance is of particular interest in view of (*a*) the low yield obtained in the Gezira area in general and (*b*), the low temperatures recorded during the growing season (minimum temperature below 10°C. on seventeen occasions and falling at times as low as 4·5°C).

The difference between the two areas is attributed to the fact that, although at both places the summer rainfall was abnormally heavy, in the case of Shambat the precipitation was almost confined to the period just before sowing, thus avoiding the prolonged waterlogging of the young plants which is believed to have been the main cause of trouble in the Gezira.

It is considered that events have fully confirmed the conclusion which was reached at an early stage of the work here that a "cold winter" in this district or in the Gezira is unlikely to affect the final yield adversely, unless other unfavourable circumstances have been acting previously in the early stages of crop development, which have suppressed the production of flowers at the normal time. The low temperatures had, however, a very marked effect in prolonging the maturation period of individual bolls, the delay in the case of Shambur Sakels being as much as ten days, and the suggestion is made that this prolonged period of confinement within the boll is connected with a noticeable darkening in the colour of the lint (p. 206).

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* May 1st, 1929, to April 30th, 1930.

† Throughout this report the words "*rottle*" and "*feddan*" can be taken as being equivalent to "*pound*" and "*acre*," the approximation in both cases being very close indeed.

A "Kantar" of seed cotton is equal to 315 rottles (pounds). Yields given in kantars per feddan can consequently be read as equivalent to yields in hundreds of lbs of *lint* per acre for comparative purposes.

An extensive tour was undertaken during December and January in the southern rain-cotton districts of the Sudan and in Uganda. The causes of the relatively low yields obtained in Uganda, especially in the present season, and in certain parts of the Southern Sudan are discussed (p. 207). Restricted root development, with consequent liability both to waterlogging and drought, is considered to be likely to be a most important factor.

Excellent results are recorded in the Nuba Mountains district of the Sudan and very satisfactory results from certain areas in Mongalla.

Blackarm disease, except in certain limited areas, was not considered to be a factor of the first importance as affecting the yield of rain-cotton in the Sudan and Uganda.

A visit was made to the Gezira area towards the end of the season (p. 208).

The opinion was formed that the low yield obtained in the Central and Southern districts was chiefly brought about by waterlogging due to excessive rainfall, and that leaf curl disease under these particular circumstances had had a most important effect in crop reduction.

Leaf curl disease was general throughout the Gezira, but was much less serious at Shambat than in the previous season.

An attempt is made on p. 213 to explain the difference which certainly exists between Shambat and the Gezira in the matter of the incidence of leaf curl disease. It is suggested that the development of the disease (as apart from its transmission) depends in some way on soil conditions, the important factor being the permeability of the soil and its relation to waterlogging.

An observation which is expected to be of the very greatest importance in the control of leaf curl disease has been made during the present season. It has been found that certain pure or relatively pure strains of Shambat Sea Islands, when grown in the Gezira, have shown a marked degree of resistance to the disease, and one pure-line culture of this variety when grown at Wad Medani remained *entirely free from disease*. although surrounded on all sides by other plants showing the characteristic symptoms (p. 212).

The vigorous vegetative growth and potential fruitfulness of Sea Island cotton in the northern Sudan, previously noted, are referred to (p. 213) and the stage reached in hybridization work with this variety is recorded. Hybrids between Sea Island on the one hand and Sakel, Afifi and Uppers on the other are all in various stages of fixation.

There is every reason for thinking that a type of cotton will eventually be obtained, which will be both suitable for general growth in the Gezira and either highly resistant to or completely immune from leaf curl.

Other "likely" new types derived direct from Egyptian or Sea Island cottons by selection are referred to on p. 211.

In the American Breeding Plots the outstanding successes were the progenies from a selection made originally from Columbia cotton in 1925. These appear to be both high-yielding and early, and there seems to be no reason why they should not be a success under rain-cotton conditions in the Southern Sudan (p. 210).

A new substrain has been bred out from "Delrect".

The system of propagation employed by this Section is detailed on p. 215 *et seq.*

The progress made with the propagation of Delrect and Sakel 186, which are shortly to be offered for wide scale distribution, is noted.

Sufficient seed has now been obtained of one of the most promising strains of the ex-Columbia selection (see above) to enable it to be tested in the coming season in our standard American Variety Tests, where it will be tried out under the full range of conditions found in the American cotton-growing areas of the Sudan (p. 217).

A full report on the results of Variety tests is given on pp. 217 to 240, a list of the actual tests and localities being given on pp. 217 and 218.

In the Egyptian-type series the most striking results were the relative resistance to leaf curl shown in the Gezira tract by Shambur Sakel I, which is an acclimatised Sea Island type with shortened staple falling roughly within the Sakel class, but superior in fineness and lustre, and the behaviour of Pima cotton, grown for the first time, this season, in the Sudan. The latter was found to be extremely susceptible to Blackarm—to a degree which would preclude any further attempt to grow it in that area. There is good reason for thinking that the same observation would apply also to the closely related Maarad type (pp. 225 and 228).

The three Sakels tried (including Sakel 186) all gave rather similar results (pp. 225 and 227), Sakel B/24 being the least satisfactory as regards both yield and ginning out-turn.

Figures relating to the relative susceptibility of the types tried to both Blackarm and leaf curl are given on pp. 228 and 229.

An account is given on p. 230 of the behaviour of a number of American cotton varieties in a preliminary "line" test under irrigation at Shambat.

The best results as regards yield were given by a selection from Pump Scheme (X.A. 7/28).

Parnell's U.4, did not show up particularly well under "irrigation" conditions, but once more gave indications of being one of the most resistant to leaf curl disease, and, with Parnell's A.12, was characterised by a decidedly high ginning out-turn.

The results obtained from the American cotton variety tests (standard series) in the rain-grown areas of the Sudan are summarised in tabular form on p. 235, and diagrammatically on p. 237. The varieties varied considerably in ginning out-turn, and the final order of yield (based on *lint* per unit area) differs very much from the order of the same varieties based on weights of seed-cotton. This is particularly noticeable in the case of " Uganda S.G.15 ".

The advantages and drawbacks of the different types are set forth in the pages immediately following the Table. Uganda S.G.15 is handicapped by its ginning out-turn and by its exceptionally long lint; Wild's No. 1 gave very satisfactory results in the more northern plots but was less successful in the south, due probably to its susceptibility to Blackarm; Webber 49, Strain 2 gave the poorest results, taken on the whole; Delrect, allowing for its relatively high ginning out-turn and the quality of its lint, gave about the best all round performance in Gedaref and Mongalla, but was disappointing in the Nuba Mountains, where the local Pump Scheme type was, this year, the most successful of all.

The view, advanced last year, that low soil-moisture content is associated with low ginning out-turn is confirmed (p. 239) on the whole.

Graders' and spinners' reports on the 1928/29 crop have been received and the results from these are summarised in the form of Tables, graphs and diagrams on pp. 240 to 257. Fig. 5 on p. 253 affords an interesting comparison between five different American varieties, as regards the effect of varying environmental conditions and also shows the relative position of the varieties as regards valuation, staple length etc.

An interesting feature of the season's results, as regards spinning tests, is the good performance of Pump Scheme Strain in the lea tests and, to a less extent, in the ballistic tests. This does not accord with the previous season's results.

The opportunity was taken to compare the effect of roller-ginning and saw-ginning on identical samples of five different varieties. The results are summarised on p. 252 and in Figs. 7 and 8. The grader's judgments show very clear differences. The colour and grade are " improved " in almost all cases by saw-ginning, but the staple length, strength and valuation all show a strong tendency to drop. No definite trend in either direction can be shown to exist in the matter of yarn-strength and total waste, but the resulting yarns were stated to be more level and free from nep in the case of the roller-ginned subsamples.

Observations made on bud-shedding and boll-shedding at Shambat show considerable differences from last years' results (p. 258).

Irregularities in the flowering curve were very clearly foretold in the records obtained for bud-shedding, and the latter is established beyond doubt as being the most important factor in crop production at Shambat.

An account is given on pp. 258 to 267 of certain preliminary experiments conducted in the Southern Sudan, in which this section co-operated. An " Origin of seed " test carried out in the Nuba Mountains suggests that little or no difference occurs in the behaviour of seed which has been grown for one year in the district instead of being imported fresh from the northern Sudan, as has been the practice up to the present. " Two year old " seed, however, gave a decided drop in yield which may possibly have been due to accidental circumstances (p. 260).

A " Dates of Sowing Test ", carried out in four localities in Mongalla, gave results strongly in favour of sowing about mid June (p. 262), and appeared to show that Uganda Cotton (N.17) was capable of giving higher yields in those districts than either Pump Scheme or Delta Webber. (A full trial is being given to Uganda N.17 in variety tests in the coming year).

A series of very preliminary variety tests (" Observation Plots ") was carried out at four localities. As far as it is possible to draw conclusions from these experiments, it would seem that Delta Webber gave the most generally satisfactory performance (pp. 265 and 266) whilst Webber 49, Strain 2 gave consistently poor results. Uganda S.G. 15 and Pump Scheme Strain were the types most affected by Blackarm in these tests.

Part II.—Introductory.

Staff.

Mr. F. E. Kenchington left the Section on October 1st 1929 in order to take up the duties of chief of the newly-formed Horticultural Section.

His place as Assistant Plant Breeder has been taken by Mr. R. L. Knight, a former holder of one of the Corporation's Studentships.

Mr. Knight commenced duty with the Section on September 29th.

Approval has been obtained for the appointment of one additional Sudanese assistant in Grade VIII. Some difficulty has been experienced in obtaining suitable candidates for this post, but it is hoped that an appointment will be made in the near future.

Buildings.

One additional house for British staff has been erected during the present season and another is practically completed.

A very useful "mixing-room" has been added to the building which contains the gin and baling machine. A large moveable wooden grid has been placed in this room and will be used as a "floor" on which subsamples from variety test plots can conveniently be cleaned and mixed before baling.

Experimental Farm.

An area of $3\frac{1}{2}$ feddans has been taken in as a permanent addition to the farm, in order to increase the area which can be devoted, in rotation, to the breeding and propagation of American cottons. Three feddans were also taken over temporarily for the purpose of propagating a new strain of Castor-Oil seed.

The total area of the farm in the present season was, therefore, $98\frac{1}{2}$ feddans, made up as follows:—

Cotton	$23\frac{1}{2}$ feddans.
Dura and Maize	3 ,,
Berseem	10 ,,
Lubia and other beans	$2\frac{1}{2}$,,
Pigeon Pea	$1\frac{1}{2}$,,
Castors	4 ,,
Wheat	$\frac{1}{2}$,,
Dukhn, Simsim, etc.	$\frac{1}{2}$,,
Miscellaneous	$\frac{1}{2}$,,
Fallow	34 ,,
Trees, etc.	$18\frac{1}{2}$,,
	$98\frac{1}{2}$ feddans.

A variety test plot of five feddans, situated on the Shambat Pump Scheme was also "run" by the staff of the Experimental Farm.

General.

The yields obtained in the present season were very satisfactory for the Shambat district and well above the average obtained for the Gezira irrigated tract.

Omitting the Breeding plots and other small broken-up areas on the Experimental Farm, the average yield for the farm was just under four Kantars per feddan (1,245 lbs. per acre) for irrigated cotton of Egyptian or Sea Island type. American cottons gave even higher yields, but the areas grown were not sufficiently large to allow of any useful estimates of yield per feddan being given.

The Shambat Pump Scheme as a whole reflected the rise in yield, shown by the Experimental Farm, and the Government Pump Schemes

RESEARCH FARM, SHAMBAT — METEOROLOGICAL READINGS 1929/30

(3-day sliding mean)

| | | |

north of Shambat, also, for the most part, showed better yields than in the previous season, though in certain individual cases, such as Gendettu and Mikeilab, accidental circumstances (locusts and flooding from the river) caused heavy losses of crop.

The figures for these stations for the last three seasons are given below in Kantars (315 rottles) per feddan :—

	1927–28.	1928–29.	1929–30.
Shambat (Sakel Cotton)...	2·6	2·0	2·9
Gendettu (American Cotton)	1·8	3·8	1·9
Kitiab ,, ,, ...	2·9	2·6	3·1
Mikeilab ,, ,, ...	3·3	4·1	2·5
Bouga ,, ,, ...	3·6	1·9	1·8
Nuri ,, ,, ...	4·1	3·4	4·8
Gureir ,, ,, ...	4·6	2·3	3·2
Ghaba ,, ,, ...	3·9	1·5	2·7
Kulud ,, ,, ...	—	4·8	5·3

The high yields obtained at the Experimental Farm and on some of the Pump Schemes are of particular interest in view of the fact that the winter, as a whole, was colder than usual, the minimum temperature on 17 occasions falling below 10°C.

The climatic conditions experienced during the season are summarised in Fig. 1 where the maximum and minimum temperatures (smoothed to 3-day means) are compared with the " normals " for the district. Rainfall is also indicated, but relative humidity has not been included in the diagram owing to the large and at present inexplicable differences which occur between the readings taken at Shambat and others taken at places situated at a very short distance away.

The rainfall was nearly twice the normal for the district, but most of this fell before the cotton on the farm had been planted and, apart from spoiling the tilth, with consequently irregular germination in places, did no damage. It is indeed possible that this very heavy " prewatering " was one of the contributory causes of the high yield obtained.

Several flights of locusts visited the farm, but did no serious damage to cotton except in the case of late resowings in the breeding plots. Sudan boll-worm caused considerable damage to an early-sown propagation-plot of American cotton, but large numbers were caught by means of a light trap and the main crop suffered very little damage from this pest. Pink and Egyptian boll-worm were abundant at the end of the season, and did very serious damage to the Shambat variety test plot, which was situated in the middle of native-grown cotton which had been sown considerably earlier and acted as a breeding ground.

The most important difference between the present season and the preceding one, as shown in the growth of the crop, was the very slight

bud-shedding which occurred in the early stages. Flowering commenced rather later than was the case last year but proceeded in a normal manner instead of, as last year, being prevented from rising to a peak by consistently heavy bud-shedding.

In the " Observation Plot " flowering started in the last week of October, attaining a maximum about the middle of November, and fell off to practically nothing by mid-January. The second flush of flowers was very small in quantity.

The cold weather caused the period required for individual bolls to ripen to be very considerably prolonged, the delay in the case of Shambur-Sakels being as much as 10 days during the period January-March. There is reason for thinking that this delay was directly responsible for the cotton being very dark in colour when picked; otherwise the delay and the cold weather which brought it about had very little effect on the crop and it may be taken as certain that a " cold winter " in this district or in the Gezira is unlikely to affect the final yield adversely, unless other unfavourable circumstances have been acting previously in the early stages of crop development which have suppressed the production of flowers at the normal time.

Part III.—Experimental Work, Etc.

1. Inspection of Cotton Areas.

(*a*) During the course of the present season a prolonged tour was made through the principal rain-cotton areas in the Nuba Mountains and Mongalla. Observations were made on the variety test plots and other experimental plots located in those areas, the results from which are recorded later in this report, and the opportunity was taken to study the local conditions and difficulties under which cotton is being grown in those parts.

At the request of the Empire Cotton Growing Corporation the tour was extended into Uganda in order that a study might be made on the spot of possible means of assisting cotton-growing in that country. Separate reports have already been submitted on this subject.

An opportunity was thus afforded of comparing the behaviour of the crop in the two countries. As it turned out, the comparison was very strongly in favour of the Sudan, as regards the growth and yield of the plant, but it so happened that an exceptionally bad season was being experienced in Uganda, and the crop there was abnormally light.

It seems unlikely, however, that, even under the most favourable conditions, any one district in Uganda can compare with the more favoured portions of the Nuba Mountain District as regards cropping

powers. Excellent results were obtained once more in this particular district.

The yield in Uganda is always low when the abundant rainfall is taken into consideration, and it is difficult to assign any single cause for this state of affairs.

The West Nile district of Uganda shows many similarities to the Yei district in Southern Mongalla. Cotton-growing in both these places has proved to be unprofitable and it is probable that the same cause is operating in both. Judging by the conditions noted at Yei it seems possible that the reason may lie in the amount of cloudy, overcast weather experienced there during the growing season. Previous observation has shown an undoubted connection between shade and bud-shedding and it is conceivable that this factor is responsible here. Shading experiments will be carried out in the coming year in order to test this point.

The opinion was formed that the relatively low yields obtained in the rest of Uganda were due primarily to shedding and not to disease, except in certain limited areas where Blackarm was bad, and that the shedding, in turn, was connected with the shallow-rooting habit of the plant which was noted in much of the country and which would cause it to be waterlogged during heavy rain, and later, during the dry season, render it liable to drought.

The symptoms of drought and waterlogging are rather similar, so that the two phases would be difficult to tell apart without recurrent observation. In the Eastern and Northern Provinces it is probable that the drought phase plays a much more important part than in Buganda.

It would be interesting to know whether this feature of shallow-rooting noted during a very rapid tour of the country is general, and, if so, to what extent it is due to the presence of a layer of heavy clay which is often found a few inches below the surface.

It is probable that the conditions affecting the growth of cotton in the North and East of Uganda will also hold good to a great extent in South-Eastern Mongalla where the soil, grass and climatic conditions appeared to be similar.

In the course of the present tour, cotton improved very considerably from Lira in the Lango district of Uganda, northwards to the frontier of the Sudan and excellent crops were found in Southern Mongalla itself in the neighbourhood of Torit and Opari. This district appears to be definitely suitable for cotton, though the staple in this season tended to be short. Shedding had been very moderate in most of the fields examined, but it is possible that in some years cloudy weather

might have somewhat the same effect as that noted in the Yei district.

Meridi district in South-Western Mongalla was also visited and was producing excellent crops of good staple cotton. This appears to be a promising area and quite suitable for cotton, except that in certain seasons the rainfall may tend to be too heavy and continuous, in which case the plants may suffer from waterlogging as has been suggested to be the case in Buganda.

(*b*) A short visit was made to the Gezira tract towards the end of the season, with the object of gaining some information as to the circumstances attending the drop in yield which has been experienced in the central and southern portions of that area during the present season. A circuit of about 120 miles was taken and frequent examinations of the plants made en route.

In general it may be stated that the crop became increasingly poor towards the southern end of the district and there can be little doubt that the relative failure in those parts was intimately connected with the abnormally heavy rains experienced there during and after the planting period. This affected the crop in at least three ways : (i) by killing the young plants by flooding or washing-out, necessitating frequent resowings, (ii) by producing conditions favourable to the development of Blackarm, and (iii) by leaving the soil in a water-logged condition.

Leaf curl disease was general throughout the area at the time that the inspection was made, and it was noted that the later resowings had in practically all cases developed this disease right from the start, whereas only the upper portion of earlier sown plants was affected.

In all cases Blackarm, as evidenced by lesions on the stem, branches and receptacles, was largely confined to the lower half of the plants. In Efeina (the best crop seen in the area visited) numerous cases were seen of plants which carried severe lesions in the region represented by the bottom 12 nodes of the stem, but above that zone the plants had branched out strongly and produced a good crop. It would appear therefore that a heavy early attack of Blackarm does not necessarily affect the growth and fruiting of the plant adversely for the rest of the season. The general impression was formed that Blackarm had been severe in the early stages, but that plants which had been able to survive this attack, *and which had not suffered from other causes*, had been able to produce a reasonable crop despite cold weather which must certainly

have tended to slow up the process of development, though otherwise not injurious in any way.

The conclusions reached were as follows :—

1. *Widespread waterlogging* had been the most important factor. Apart from predisposing the plants to Blackarm attack, it had carried the average sowing date well after the optimum time, thus exposing the plants to the maximum leaf-curl effect, and had produced soil conditions specially unfavourable for root growth which in certain cases *had lasted throughout.* It had also given rise to a copious growth of weeds, which must have competed very severely with the crop.

2. *Cold weather* had to some extent slowed down growth, but (as shown by the excellent growth and fruiting of late-sown plants at Shambat) would not have been a factor of any importance at all if operating alone.

3. *Blackarm* was serious in the early stages and caused a loss of early crop, but probably not much more than in most other years. By killing a number of young plants outright it added to the effect of waterlogging in necessitating very late resowings. In the middle and late part of the cropping period, it ceased to be an important factor.

4. *Leaf curl* was present practically universally on all late-sown plants (i.e. resowings) and had developed on them from the start.

It appeared to be associated invariably with the weak spindly twisted growth characteristic of the Gezira plants in poor yielding areas this year.

Plants which had survived from *early* sowings developed leaf curl at a late stage, and, if not too badly stunted by waterlogging, had been able to produce a reasonably well developed zone of fruiting branches before the leaf curl zone was reached. The opinion was formed that leaf curl, under the circumstances brought about by early waterlogging, had had a most important effect in crop reduction.

2. Selection, Line-Breeding and Hybridization.

Work has been continued on the lines described in previous reports.

The pedigree cultures were grouped under the same headings as in previous seasons, but a further group has been added, which received the name of the " Leaf-curl breeding plot."

The following is a summary of the types grown and the number of families in each group :—

(*a*) *American* " *N.S.*" *plot* (New Selections), containing the progenies of plants which had been newly selected from bulk crops, or which had stood out in last year's breeding plots as desirable off-type plants. — 44 families.

(*b*) *American* " *P.L.*" *plot* (Pedigree Lines), containing the progeny of plants which had come from pure or approximately pure stock from the previous year's breeding plots. — 41 families.

(*c*) *Egyptian & Sea Island "N.S." plot* (a few families of Tanguis were included here for convenience). — 61 families.

(*d*) *Egyptian & Sea Island "P.L." plot* ... ... — 20 families.

(*e*) *Hybrid plot.* (Derivatives of crosses between Sakel and Sea Island, Uppers and Sea Island, Afifi and Sea Island, Tanguis and Sea Island, and Pelion and Sea Island.) — 37 families.

(*f*) *Leaf Curl Breeding plot.* Families grown from plants selected from the Gezira Sakel crop, as showing apparent immunity from leaf curl disease. — 170 families.

(*g*) *Reference plot.* A collection of single plant progenies, representing all the important types in use elsewhere in the Breeding plots, and, in addition, representatives of various Asiatic and indigenous African species. — 55 families.

From the above 428 families, 863 plants were selected in the field, of which number roughly two thirds were included in our routine selfing operations. The produce of all these plants was examined later in the laboratory and final selections made from them. About 250 selected plants will be carried on for the coming season, including a certain number of fresh selections from outside sources.

The yields obtained, both of self-bred and natural seed, from single plants in the breeding plots, have been quite satisfactory, especially from the American plots, where the average yield of seed-cotton per plant was round about 130 grammes (as against about 70 grammes last season). The average yield in the Egyptian and Sea Island Breeding plots (situated on poorer soil) came out at about 75 grammes per plant—again about double that obtained in the previous season.

The total number of flowers selfed in these plots and in the "Selfing Propagation Plots" (see later) taken together, was 62,000, in this year, of which about 34% were lost by shedding. This shows a very considerable improvement on last year's performance.

In the American Breeding Plots, the outstanding successes were the progenies from a selection made from Columbia cotton. Several of these produced very attractive plants, erect and sturdy, with relatively slight shedding. All gave high yields, the best of them being actually the heaviest yielders in the "N.S." and "P.L." plots respectively. Two of the substrains were very early and there seems to be no reason why these should not be a success under rain-cotton conditions in the Southern Sudan. The original selection was made in 1925 and four substrains of rather similar type have now arrived at a satisfactory degree of purity. One of these substrains had already in 1928/29 been found to be pure enough for propagation, and sufficient seed is now available from this for a first year's full trial in Variety Tests in 1930. The remaining three substrains will enter on the propagation stage from now onwards and will be subjected to a small-scale preliminary yield trial in 1930.

A new substrain has also been bred-out from Delta Webber, which appears to be a more vigorous grower than is usual in derivatives of this type and to be slightly superior in lint quality and ginning out-turn to our present selected strain known as " Delrect ".

A cross has been made between a strain of Lone Star and a type which was selected here in 1926 from Pedigree Dixie.

The latter shows the exceptional vigour of the typical Pedigree Dixie plant, but, unlike that type, stands rigidly erect and bears long, lustrous lint. It gives a high yield and would appear to be a very satisfactory type except for the fact that it shows a definitely low ginning out-turn. The present cross is made with the express purpose of overcoming this defect, but should also give other interesting results as the parent plants both come from pure-line stock and differ markedly not only in ginning out-turn, but also in such characters as height, hairiness, node development rate, lint length and seed-fuzz.

The Egyptian and Sea Island Breeding plots suffered to some extent in the early stages from the effects of waterlogging, and difficulty was experienced in getting a good stand in several families owing to locusts destroying the resowings. Those that survived, however, did very well.

Two families out of six derived from an off-type long-linted plant selected originally from a family of Afifi cotton in 1927/28 turned out well and the resulting seed will be used in a preliminary yield trial in the coming season. One of these has nearly white lint and the other dark cream, but both are well up to Sakel length. Other interesting types that have done well are two " heat-resistant " selections from Sakel and some other selections from Sakel, sent in originally by Mr. A. R. Lambert, which are remarkable for their heavy growth of monopodial branches and general lateness, but which have, in some cases, given very high final yields. The quality of these latter strains is, for the most part, much below that of " normal " Sakel, but one family, apparently pure for vegetative type, is " splitting " in regard to lint characters, and it is hoped that selections made from this will give the desired result.

Two types originally selected from Sea Island cotton are also promising at this stage. Both have excellent lint and open their bolls well, but one has the characteristically low ginning out-turn of Sea Island. The other has a satisfactory ginning out-turn and showed promise of good yielding power both in the Breeding Plot and in a preliminary yield test carried out this year.

The " Leaf-Curl Breeding plot " gave disappointing results owing to the very light attack of leaf curl which occurred at Shambat this

year, which made it impossible to say whether any particular selections were resistant to the disease or not. A number of re-selections have been made from the plot and seed from each of the families from which selections were made will be grown in the coming year at the Gezira Research Farm, Wad Medani, in order to test-out their resistance there. Seed from all the more promising substrains of Egyptian and Sea Island types in our breeding plots will also be sent to the Gezira Research Farm in the coming year, in order that they may with more certainty be exposed to infection and a decision arrived at as to their relative susceptibility.

In last years' report it was stated that an interesting parallelism had been noted between resistance to jassid attack and resistance to leaf curl, and the possibility of the jassid being the vector of the latter disease was referred to. It now seems unlikely that the two are directly connected and evidence has been obtained by other workers in this country and elsewhere that " White Fly " is the probable agent in the dispersal of the disease. If this is finally proved to be the case, then it is possible that the factor conferring immunity from jassid attack also causes the plant to be distasteful to White Fly.

Another very interesting point has come up in this connection. In our 1928-29 reports it was recorded that the pure Sea Island types and hybrids between them and Sakel at Shambat appeared to be very susceptible to the disease, so much so that a large number of strains were eliminated forthwith.

In the present season (1929-30) certain pure or relatively pure strains of Shambat Sea Islands have been grown in the Gezira at Wad Medani and Barakat, and it has been found in all cases that they showed *markedly greater resistance* to leaf curl than any of the surrounding types of Sakel.

At the request of Mr. Lambert, of the Gezira Research Farm, seed of a pure line (42/28 No. 6) of a strain of Sea Island previously grown at Shambat was supplied to him for sowing at Wad Medani, and he has since reported that the resulting plants have remained *entirely free* from leaf curl, though surrounded on all sides by other plants showing the characteristic symptoms.

This particular plant came from stock which had been very heavily infected with leaf curl at Shambat, a district where the disease is much less certain in its appearance than is the case in the Gezira, and this change in behaviour is very difficult indeed to explain. It might be suggested that leaf curl at Shambat and in the Gezira are two different diseases, and there is some slight evidence for this in the mode of attack at the two places, but it seems almost impossible to hold this opinion

when it is remembered that leaf curl has only just appeared in the country and that it appeared in both districts simultaneously. It appears to be more feasible to suggest that the development of the disease (as apart from its transmission) depends in some way on soil conditions, and that the strong-rooting habit of the Sea Island plant enables it to make use of the Gezira soil in a manner which is not possible for Sakel.

At Shambat a layer of hard, almost impermeable soil lies at a short distance below the surface, and, if conditions are unsuitable for growth in the early stages, the roots of both Sea Island and Sakel plants fail to penetrate this layer. Under such conditions it may be suggested that both varieties are equally liable to develop the disease when the necessary agent of transmission is present. On the other hand, if the plants grow away strongly from the start as in the present season at Shambat, it is probable that the roots of the majority of the plants penetrate this pan and are able to make use of the more open-textured soil below. This suggested explanation would also account for the comparatively very slight attack of leaf curl at Shambat in general as compared with the previous season, when the plants remained stunted from the beginning and leaf curl developed serious proportions in parts of the farm.

It is not impossible that the determining factor in this case is water-logging, as the *surface* soil both in the Gezira and at Shambat is of necessity waterlogged after each irrigation.

The vigorous vegetative growth and potential fruitfulness of Sea Island cotton at Shambat have been referred to in more than one earlier report, and extensive use has been made of certain strains of Sea Island in hybridization work with a view to obtaining a type of plant more fully adapted for coping with the conditions which exist in the Gezira tract. It is therefore extremely gratifying to find that we have also in, at any rate, some strains of this variety the factor of natural immunity to leaf curl disease.

Steps are being taken in the coming season to try out, from this point of view, some of the various hybrid derivatives which have now reached a sufficiently advanced stage of purity. It seems probable that the control of leaf curl disease in this country will ultimately be brought about on these lines.

Four of these hybrid derivatives (7th generation from Sakel and Sea Island cross) have this year reached the stage when propagation on a small scale can be begun and others should shortly be ready.

A cross made in 1928 between Sea Island and Afifi has given particularly promising results and steps are being taken to push this on at the rate of two generations per year.

The F3 generation from a Sea Island by "Uppers" cross was grown at Shambat in the season under review and this also promises to give very useful results, some of the families already showing a remarkable degree of purity for lint and vegetative characters.

The "Reference Plot" was carried on as in previous seasons, but it was found to be impossible to continue the interesting series of records on leaf curl immunity, owing to the lightness of the attack which developed here this year.

Seed of a cross between Meade cotton and G. tomentosum was supplied by Dr. Harland from Trinidad with a request that records should be kept on its behaviour, with especial reference to drought- and disease-resistance. Unfortunately the greatest difficulty was experienced in getting the seed to germinate and only after repeated trials was it possible to obtain three small plants in pots. These commenced growth so late in the season and grew so slowly in the early stages that no report on them is so far possible.

3. Propagation.

The following propagation work was carried out in the 1929-30 season :—

(*a*) American Cottons.

"*Selfing Propagation Plots*"—

Delrect No. 2 (area $\frac{1}{30}$ feddan approx.)
Uganda S.G. 15 ,, ,, ,,
Wilds No. 1 ,, ,, ,,

Isolated Propagation Area—

Uganda S.G. 15 (area $\frac{1}{2}$ feddan).

"*S.F.T.*" *Plots*—

Delrect No. 2 (area $\frac{3}{5}$ feddan).
"Early Meade" (ex. A. 16/28) ,, ,,
Columbia (Off-type) (ex. A. 27/28) ,, ,,

Roguing Plot—

Delrect No. 1 (area 34 feddans).

(*b*) Egyptian and Related Cottons.

"*Selfing Propagation Plots*"—

Sakel 186/24 (area $\frac{1}{30}$ feddan approx.)
Shambur Sakel II. ,, ,, ,,
Shambur Sakel III. ,, ,, ,,
Shambur Sakel IV. ,, ,, ,,
Shambur Sakel V. ,, ,, ,,

"*Out-of-Season*" *Propagation Areas*—(area $\frac{1}{5}$ feddan).

Sakel 186/24 (area 4 feddans).

"*S.F.T.*" *Plots*—

Shambur Sakel (area $\frac{1}{5}$ feddan approx.).

Bulk Propagation Plots—

Shambur Sakel II. { Nucleus area $\frac{3}{4}$ feddan. Belt area ... $1\frac{1}{4}$,,
Shambur Sakel IV. { Nucleus area $\frac{1}{2}$,, Belt area ... 1 ,,
Shambur Sakel V. { Nucleus area $1\frac{3}{5}$,, Belt area ... 1 ,,

Roguing Plot—

Sakel 186/24 — Nucleus area 1 feddan. Main area ... 15 ,, Belt area ... 8½ ,,

The following notes taken in conjunction with the summary given above will serve to illustrate the system employed here for propagation.

A "*Selfing Propagation Plot*", under our system, is a small area sown with bulked self-bred seed taken direct from a family in one of the Breeding plots.

The plants within these areas are intensively "selfed", using conical muslin nets with which to cover the flowers, thus giving rise to a stock of pure inbred seed.

An "*Isolated Propagation Plot*" serves the same purpose as the Selfing Propagation Plot, but depends upon segregation to prevent cross-fertilization taking place.

"*Out-of-season*" *Propagation plots* are grown during the "dead season" when other cotton is off the ground. They are intended to perform a similar function to that of the Isolated Propagation Plots.

"*S.F.T.*" ("Seed For Testing") plots are intended solely for the rapid multiplication of less pure seed for use in Variety tests only. They are sown with seed (mostly "natural") from bulk pickings taken from selected families in the Breeding plots.

No attempt is made to isolate these plots, as a small amount of cross-fertilization is immaterial in this case.

"*Bulk Propagation plots*" are usually made up of two portions—an "inner" Nucleus area and an outer protective belt. The nucleus area is, in the ordinary way, sown with self-bred seed taken from a "Selfing propagation plot" of the previous year, and the belt area with "natural" seed.

"*Roguing Plots*" are similar in principle to the Bulk propagation plots and consist of a Nucleus area, sown either with self-bred seed or with seed from the Nucleus area of a previous season, surrounded by a Main Roguing Plot area, which in turn is surrounded by a protective belt to cut off the whole plot from neighbouring cotton. Careful roguing is done in the Nucleus and Main areas, but not in the belt. Roguing is also carried out, where considered necessary, in all the other kinds of propagation plots detailed above.

Short notes on most of the kinds grown in these plots were given in last year's report. It will be sufficient here to give some particulars about "Delrect" and "Sakel 186/24", the two kinds which have gone furthest in the process of propagation and which it is intended to put out for general distribution in the near future, and also about

" Early Meade " and " Columbia Off-type " which were grown in the S.F.T. plots.

(i) *Delrect.*—Two strains of this are now being grown, " Delrect II " being an offshoot at a later date from the Pedigree Line which had given Delrect I in 1927/28. Delrect II is very similar in all respects to the earlier strain but is looked on as being of even better quality and more vigorous and fruitful.

Considerable ill fortune attended the first year's attempt to grow Delrect I on a " Roguing Plot scale ". An area of 40 feddans was selected at Mikeilab of which 20 feddans was regarded as the Main Roguing Plot and the rest as " belt ". Unfortunately, the exceptionally high Nile flooded the whole area shortly after sowing and an area of 10 feddans was washed completely away into the river. Much of the remaining cotton was destroyed. The land had to be resown, but this was not possible until a very late date and stocks of seed were then very low. A small additional area of four feddans was sown after the flood had subsided, to compensate in part for the land which had been washed away, making a final total of 34 feddans.

The crop thus got a very late start and was further held back by the after-effects of water-logging, with the result that the bolls became heavily infested with boll worm and were largely destroyed. The final yield came out at only 268 rottles of seed cotton per feddan.

Propagation of this type will be continued at Mikeilab in the coming year, but the area which can be sown with the seed available will not be more than 300 feddans.

(ii) *Sakel* 186/24.—An attempt was made in this case to accelerate the rate of increase by taking two crops in one year. The attempt was successful in that, starting with the produce from a small area of ⅖ths feddan in 1927/28 we finished up at the end of the 1929/30 season with approximately 4,500 rottles of seed, whereas only about 3,000 rottles could have been expected if the propagation had been done in one step only. Considered purely as an agricultural operation the experiment was far from being a success. The early-sown crop had perforce to compete with the conditions which occur during the hottest and driest period of the year, and gave a low yield in consequence. The subsequent sowing was necessarily very late and suffered not only from neglect on the part of the cultivators (who had only been induced to grow it on a basis of compensation for loss of crop) but also from a very heavy invasion of boll worm from the early-sown cotton around.

The seed actually obtained will be sufficient to sow only about half the area of the Pump Scheme at Shambat in the coming year, even with the inclusion of the seed obtained from the " belt " area. It

will not be possible to distribute any seed for a bulk trial in the Gezira in the coming season, as originally intended.

(iii) "*Early Meade*" (*ex A* 16/28) *and* "*Columbia Off Type*" (*ex A* 27/28). Small plots of these two kinds were grown at Shendi with a view to working up stocks of seed for inclusion in variety tests. Both are new types which have come direct from the American Breeding Plots at Shambat, where they originated as selections from "commercial" stocks of Meade and Columbia respectively.

The former has the characteristic long lint and high quality of Meade cotton, but has the added characteristic of earliness and has given satisfactory yields. The type appears to be fixed, but suffers from the disadvantage of a low ginning out-turn.

The other type did very well indeed and gave a yield of $4\frac{1}{2}$ large Kantars per feddan (=1,300 lbs. seed cotton per acre), despite the fact that it was stripped bare of leaves and flowers by an invasion of locusts which took place in August.

The growth, which resembles type-Columbia, except that the plants are more slender, more erect and less inclined to shed, was extremely vigorous and satisfactory in general. It was not possible to obtain any data as to earliness in this case, owing to the attack of locusts, but the strain is the same as the one referred to in the previous section of this report, dealing with the results obtained from the Breeding plots, and there is every reason for thinking that it is satisfactory in this respect. The cotton which is of about $1\frac{1}{4}$" staple, when grown under irrigation, is of good quality and nearly pure white in colour. The seed from this plot is being used for trial in the coming season, under the distinguishing number X.A.2728, in the standard American Variety tests, where it will be tried out under the full range of conditions found in the American cotton areas of the Sudan.

It is hoped that this type or one of the substrains derived from it may ultimately be found suitable for general distribution in this country.

4. Cotton Variety Testing.

The following is a summary of the tests carried out :—

(A) Egyptian and Allied Types of Cotton.

I. Line Test.
Experimental Farm, Shambat.

II. Preliminary Variety Test (*Irrigated*).
Experimental Farm, Shambat.

III. Standard Test Series (Irrigated).

(i) Shambat Pumping Station.
(ii) Wad Medani (Gezira Research Farm). } Gezira tract
(iii) Barakat (Sudan Plantations Syndicate Seed Farm).

(B) American Types of Cotton.

I. Line Test.

Experimental Farm, Shambat.

II. Standard Test Series (Irrigated).

(i) Shendi (Karu soil). } On Gendettu Pumping Scheme.
(ii) Moeis (New river-soil).

III. Standard Test Series (Rain-grown).

(i) Talodi. } Nuba Mountains district.
(ii) Kadugli.
(iii) Bueda. } Gedaref district.
(iv) Fau.
(v) Yei. } Mongalla (Yei district).
(vi) Kagelu.

The general scheme is similar to that of the previous year, but two plots have been started in Mongalla for the first time, and the two plots which were sited last year in Fung Province have been transferred to the Gedaref district, which has now been opened up by the arrival of the railway and shows very considerable promise as a cotton-growing area.

The Mongalla plots (Yei and Kagelu) were sited on gently-sloping land, typical of the area in which cotton has at present been grown in those parts, the subsoil being red laterite. The rainfall in this district averages about 55 inches.

The two new plots in the Gedaref district were situated on black "cotton soil". The normal rainfall there is probably about 25 inches. The sites chosen for the plots were selected as being typical of the area which it is proposed to develop in that district.

The "Line Tests" at Shambat (American and Egyptian type cottons) are a new feature in the programme and are designed to give a rough preliminary indication of yielding power, when only very small quantities of seed are available. The number of new strains now coming on from the Breeding plots is so considerable that some such rough preliminary test has become essential for purposes of rapid elimination. The method will be further developed in the coming season.

The data obtained from the Variety Test plots have been worked up in an exactly similar manner to that employed last year.

In the case of the " Standard " series of tests, both Egyptian and American, five varieties were tested in each plot. Each variety occurred five times in each plot, each set of repetitions being grouped into a block. The arrangement of varieties within the blocks was " balanced ", no variety occupying the same " position " within the block more than once, otherwise the arrangement of the individual beds was a " random " one.

Fisher's " analysis of variance " method has been employed, the stages being as follows :—

(i) Calculation of total variance.

(ii) Estimation of *residual* variance, after eliminating variances due to varietal differences, soil heterogeneity between blocks and soil fertility gradient within blocks.

(iii) Estimation of the significance of the variance due to varietal differences by comparison with residual variance by means of the " Z test ".

(iv) Comparison of the variance due to differences in yielding power of all *pairs* of varieties with the residual variance and estimation of the significance of these varietal differences by means of the " Z test ".

A probability of P= .05 (20 to 1) is taken as the lowest limit of significance in making these comparisons.

Wherever the regularity of " stand " within the plots has permitted, " *probable corrections* " to variety yields have been worked out, based on the deviations of the average yield values of adjacent beds, taken three at a time, from the mean values of the three varieties which occur in those beds (*cf.* Report for 1928/29). These " probable corrections " may be expected to place the varieties more nearly in the true order in which they should stand if unaffected by purely accidental circumstances.

In presenting the results the *actual* yield is given, together with the " probable corrected yields ". The calculations of variance and the comparisons made from these variances, are, of course, based on the actual yields, before attempting to apply any correction.

The results of comparisons made between varieties by this method are shown diagrammatically, using the system devised last year. The varieties are arranged in the diagram around the circumference of a circle. When the difference between any two varieties is highly significant the varieties are joined by a solid line in the diagram ; when it is only just significant they are joined by a broken line, and when nearly but not quite significant by a dotted line. The arrow in each

case leads from the variety with the higher observed yield to that with the lower. Varieties which are not significantly different in yield are left unjoined.

(A) *I.* Egyptian, etc., Line Test.

Single lines, 100 metres long, of the varieties to be tested were grown between two lines of a "control" variety, "Massey's Selected Domains Sakel" being chosen for this latter purpose.

Six new types were included in the test, and, in addition, the "control" variety was grown against itself in one row.

New strains tried :—

"Afifi-derivative"	A descendant of the old Afifi-stock introduced into this country several years back. No longer a typical Afifi either in habit or in lint.
Shambur Sakel V	A derivative from imported Sea Island cotton.
X.O2428	An off-type selection from a strain known as "S.I.A."
X.O5728	An off-type selection from Sea Island stock (G.X.12) imported in 1925.
X.H.428	A "fixed" type derived from a cross between Sakel and Sea Island.
X.H.1428	Same origin as X.H.428, but quite different lint character.

Germination was very satisfactory and a good even stand of plants was obtained in all rows. Growth was rather more vigorous than is usual for Shambat, and yields were relatively high.

Pickings were taken at intervals of about a fortnight, all types being picked on the same day on each occasion.

In addition to yield records, flower-counts were carried out on three occasions and the node-development rate and position of lowest sympodium and lowest "effective" sympodium were recorded, as well as the ginning out-turn, number of boll-locules and halo-length (on 40 seeds).

In order to make the comparison between the rows of varieties and the control rows on either side as close as possible, the number of plants in every row was counted, and each set of three rows brought to the same number by cutting out plants from those rows which contained more plants than others.

It is realised that, in a test of this sort in which the variety tested is grown between two rows of another variety, root interference will play a very considerable part. Against this must be put the fact that the flanking rows are sown throughout with one and the same variety. Further, as strong-rooting is an essential for any new variety

which is going to be successful in this country, it is all to the good that a weak-rooting type should be actually penalised in these early trials by the roots of the control rows pushing into its territory. The differences in height between the aerial portions of the different types was not sufficient to be likely to cause any big error.

In final yield, two varieties only—" ex-Afifi " and X.02428—gave what would appear to be definitely superior results to the control, though two others gave about the same as the control. Shambur Sakel V and X.H.428 both yielded considerably less than the control.

The ginning out-turn of all varieties was either as good as, or better than that of the control Sakel, except in the case of Shambur Sakel V which was definitely low.

All varieties produced their fruiting branches lower down than the Sakel control, but in all cases this advantage was more or less offset by a slower node production rate.

All, except Shambur Sakel V and X.H.428 were earlier than the control, both in flowering and in the arrival of the crop.

Taken all round, " X.02428 " appeared to be the most satisfactory, being superior to the control in lowness of fruiting zone, earliness, halo length and probably, in yield.

The " ex-Afifi " was easily the earliest and heaviest yielder, but the lint is definitely short and rough.

X.05728 and X.H.1428 both gave about the same yield as the control, but had the advantage over the latter as regards earliness, ginning out-turn and quality of lint.

(A) *II.* Preliminary Variety Test.

The varieties grown were as follows :—

Shambur Sakel II.
Shambur Sakel III.
Shambur Sakel IV.
S.I.D. 1.8.
Bolland Sakel 19.3.
Massey's Selected Domains Sakel.

The first three varieties are derived from Sea Island types introduced from St. Vincent some years back, and have been given the name of " Shambur Sakels " owing to the fact that their lint agrees most closely with the Sakel type.

These types are probably not suitable for general distribution owing to the fact that a large proportion of bolls fail to open properly, thus seriously reducing what would otherwise be a very high yield. They are, however, of the very greatest interest and importance in

view of their excellent vegetative growth, the high quality of lint produced and their apparent resistance to or even immunity from leaf curl in the Gezira, and it is of considerable importance to compare their yielding power as accurately as possible with other types.

Of the other three varieties, two have appeared in previous tests of this nature, the third (Bolland Sakel 19.3) being a type of Sakel originally selected here by Mr. Massey and a possible competitor with "Sakel 186."

The plot was sown on August 16th in soil still damp from rain. Germination and stand, though a little irregular in the earliest stages, were eventually excellent, individual beds not varying by more than 2%.

A dressing of Sulphate of Ammonia (three cwts. per feddan) was given on October 8th.

Growth and fruiting were very satisfactory. The plants were vigorous, shapely and flowered heavily, with relatively slight shedding. The bolls took a long time to mature owing to the cold weather, but this had no appreciable effect on the final crop which averaged about 5½ large Kantars—the Shambur Sakels giving approximately 5¼, a very high yield for these types.

Blackarm and leaf curl were both very slight and the only serious pest was Pink Boll Worm which destroyed a high percentage of bolls at the end of the season.

The final yield results are summarised in the following table, the varieties being arranged in descending order of yield.

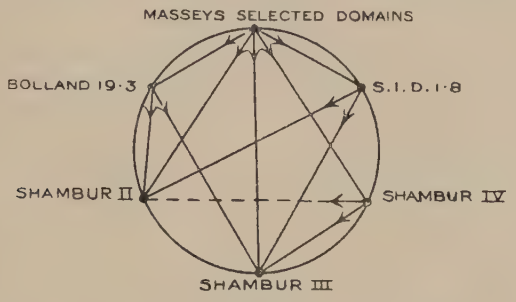
The system employed for correcting mean bed yields on the basis of yields of adjacent beds (see previous Reports) is to some extent interfered with in this case owing to the occurrence of a strip of extra vigorous growth running parallel to the length of strips 19 and 20 and affecting about half of each of those strips (the site of a filled-in drain). This has probably resulted in the "corrected yield" shown for Shambur Sakel III being rather too low, the corrected yields for S.I.D. 1.8 and Shambur Sakel II being also affected in the same way, but to a less extent.

Average net yield per feddan = 1,776 rottles per feddan.

Varieties.	*Mean Bed Yield in Rottles.*	*Corrected on Basis of Yields of Adjacent Beds.*	*Order of Merit (after Correction.*
Massey's Selected Domains ...	291·2	288·0	Unchanged
Bolland Sakel 19.3	267·2	267·1	,,
S.I.D. 1.8	256·8	260·0	,,
Shambur IV.	253·6	248·3	,,
Shambur II.	235·4	236·9	,,
Shambur III.	224·8	226·2	,,

The method of analysis of variance applied to the (uncorrected) results from this plot showed that differences in yields in the plot due to varietal differences were highly significant.

The result of applying this system to the comparison of the yielding powers of the varieties taken in pairs, is shown in the following diagram (see general notes at head of this section for explanation of this diagram).



The ginning out-turns of these varieties (average for all pickings) were as follows :—

	Per Cent.
Massey's Domains	30·0
Bolland Sakel 19.3	29·9
S.I.D. 1.8	28·5
Shambur IV.	27·6
Shambur II.	27·5
Shambur III.	27·4

Developmental observations included records of flowering, node development rate, position of lowest sympodium, height, lodging and resistance to diseases etc.

Bolland 19.3 and Shambur III were the two latest in starting to flower, but shortly afterwards all the Shambur Sakels went ahead in the matter of flower production rate and maintained their lead throughout the flowering period. The fact that they failed subsequently to head the list in yield must be attributed largely to their inability to open their bolls satisfactory. Bolland 19.3, to the end, remained the least prolific in flower production. S.I.D.1.8 was on about the same level as the Shambur Sakels, and Massey's Domains occupied an intermediate position.

The Shambur Sakels, on the average, produced sympodia two nodes lower down than did Bolland 19.3 and Massey's Domains, but this advantage (as regards earliness) was very largely offset by the more rapid node development rate of the two latter varieties.

It was found that in the case of the Shambur Sakels and S.I.D.1.8 node development rate had had a decided influence on the yields of cotton in the first picking.

(A) *III.* Egyptian, etc., Varieties (Standard Series) (Irrigated).

(i) Shambat Pumping Station.
(ii) Wad Medani.
(iii) Barakat.

The layout was on the standard strip system with five varieties, repeated five times, grouped into five blocks.

The total area of each plot, exclusive of the protective " belts " at each end (which were made use of for rough preliminary trials) was just under four feddans.

The same five varieties were grown in each plot :—

Sakel 186/24.
Sakel B/24
Shambur Sakel I.
Pima.
Gezira Main Crop (as standard).

Of these, the first two and the last had been grown in previous years in similar trials. " Shambur Sakel I " is an acclimatised Sea Island type with staple falling roughly within the Sakel class but finer and more lustrous. It was grown in the previous year in a single belt strip at Wad Medani and had previously been grown at Shambat.

Pima, the " American-Egyptian " variety raised and grown in Arizona, received its first trial in this country this year. The inclusion of this variety was of especial interest in view of its very close relation to Maarad cotton which is now being grown on a fairly wide scale in lower Egypt.

The behaviour of Shambur Sakel I and Pima in these tests is particularly interesting.

Shambur Sakel I was outstanding at both Wad Medani and Barakat in that it was *relatively slightly attacked by leaf curl*, compared with the other varieties. The results of an actual count of infected plants in Medani plots are given later and are very striking. This variety also gave the best results at Medani and Barakat in the matter of *resistance to Blackarm*, thus confirming previous experience in this direction.

It seems clear that we have in Shambur Sakel and its allied strains, material of great value in combating the attacks both of leaf curl and Blackarm, but the low yields given by this variety in all these tests, despite its relative immunity, show that it cannot be made use of as it stands. As explained elsewhere, considerable progress has already been made in the production of fixed hybrid types between Sea Island

and various Egyptian cottons, and it is from these that the desired high-yielding, disease-resistant strain may be expected.

Pima proved to be interesting from two points of view : (i) the great variation between its yielding power at Shambat, where it was easily the highest yielder, and in the Gezira, where it gave the lowest yield of all both at Medani and Barakat, and (ii) its high degree of susceptibility to Blackarm. It is certain that some at least of the difference in behaviour in the two districts is directly attributable to Blackarm, which was relatively very slight at Shambat, but it is not so clear that this was the only cause. In any event the susceptibility of this variety to Blackarm in the Gezira itself was so marked as to preclude any further attempt to grow Pima in that area, and there is good reason for thinking that the same observation would apply also to the growing of Maarad.

As regards the three types of Sakel in this series, they all gave practically identical results, Sakel 186/24 being slightly the highest (taking the " corrected " yield) at Shambat, and top at Barakat, thus confirming previous results in the matter of yielding power. At Wad Medani, however, the control Sakel gave the highest yield. Sakel B/24 was the least successful of the Sakels grown.

The results from the Barakat plot cannot be taken as reliable, as explained below, but it is probable that the comparison between Sakel 186 and Main Crop at that place is a fair one, as records show that the amount of resowings and the final stand of plants was very similar in these cases.

The " belts " of these plots were sown with the following varieties in order to obtain some preliminary information as to their behaviour:—

Garofallou ...	Belt No. 1	Shambat and Wad Medani.
Sakel Bolland 19.3	Belt No. 27	
Sakel Bolland 19.3	Belt No. 1	Barakat.
Shambur Sakel III.	Belt No. 27	

None of the above showed signs of exceeding the better of the varieties in the test plot itself as regards yield, but Bolland 19.3 appeared to show more than normal resistance to Blackarm, and may be of importance from this point of view, and Shambur Sakel III, was decidedly resistant to leaf curl and somewhat resistant to Blackarm.

The following details are given for individual plots :—

Shambat.—Sown August 22nd, but no germination took place until after watering on August 29th. Resown September 25th to replace some rather irregular damage done by locusts and ants. Thinned and spaced October 9th and 22nd. Final spacing 90 × 45 cms. Four after-cultivations given. Waterings at about 13-day intervals. Nitrate of soda, 2½ cwts. per feddan, applied on October 10th. The soil was a rather light loam and was, on the whole, even throughout the plot.

The final stand of plants was excellent, and growth very strong throughout, the only check in the early stages being an attack of "Asal" in February which was even in its distribution.

The crop would have been very heavy—probably about 5 to 6 kantars, if it had not been for a very severe attack, towards the end of the season, of Pink Boll worm, which migrated into the plot from the surrounding, earlier-sown native cotton.

Wad Medani.—Sown August 26th on soil wet with rain. Resown twice (September 2nd and 8th). Thinned on October 7th. Final spacing 80 × 50 cms., but irregular. Four after-cultivations given. First watered on October 8th (previously dependent on rain). Thereafter watered at intervals of 13–16 days, except for a period of 23 days following March 14th. The field was manured with sulphate of ammonia. The soil was of the normal Gezira type and fairly regular.

Germination was uneven and the final stand was irregular – individual beds varying by as much as 23% in number of plants. The growth was poor as in the rest of the Gezira. The plants were leggy (except Shambur Sakel) and bolls opened badly.

Blackarm was rather severe from the latter part of September to the middle of October. Leaf curl was first noted in the second week of October and spread very rapidly. Egyptian boll-worm did considerable damage at the end of the season.

Barakat.—Sown on August 27th on wet soil and almost completely resown three times, the last being carried out as late as September 25th. This resowing was necessary owing to the seed and plants being washed out by heavy rains. The plants were thinned on October 23rd, the spacing aimed at being 80 × 50 cms., but this was actually attained in one bed only. Elsewhere the stand and spacing were very irregular owing to the difficulties experienced. The plot was cultivated three times after sowing in addition to weeding. The first irrigation was given on October 10th and the interval thereafter varied from 13 to 17 days. The soil was normal Gezira soil and was badly waterlogged in the early stages.

Growth was similar to that at Wad Medani but slightly less leggy. The first picking was very late in maturing (February 20th).

Blackarm and leaf curl were similar in their incidence to Wad Medani, but leaf curl was somewhat more pronounced in this case, owing to the higher proportion of late resowings.

In general, the yield results from this plot must be accepted with considerable reserve, but an exception may perhaps be made in the case of Sakel 186/24 and Gezira Main Crop where the amount of resowing and final stand were similar in both cases.

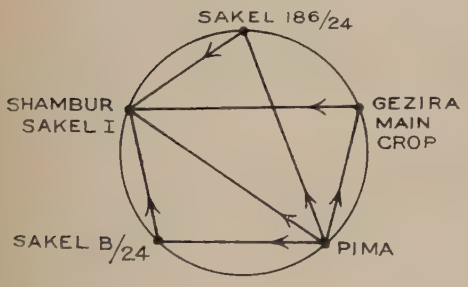
The yield results from these three plots are shown in the following table. Probable corrections on the basis of yields of adjacent beds are given for the Shambat and Medani plots, but are not attempted in the case of the Barakat plot owing to the great irregularity in stand.

Varieties.	Shambat. Average Net Yield per feddan = 929 Rottles.			Wad Medani. Average Net Yield per feddan = 677 Rottles.			Barakat. Average Net Yield per feddan = 731 Rottles.		
	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.
	Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.	
Sakel 186/24 ...	112·1	2	+1·8	94·3	2	−0·3	107·8	1	Too irregular to attempt to apply.
Sakel B/24	112·1		−2·3	91·9	3	−1·3	99·4	3	
Gezira Main Crop ...	112·6		−0·5	102·5	1	+1·0	104·2	2	
Shambur Sakel I. ...	92·7	5	+1·3	71·9	4	−1·4	86·8	4	
Pima	147·7	1	+0·6	62·9	5	+1·0	58·8	5	

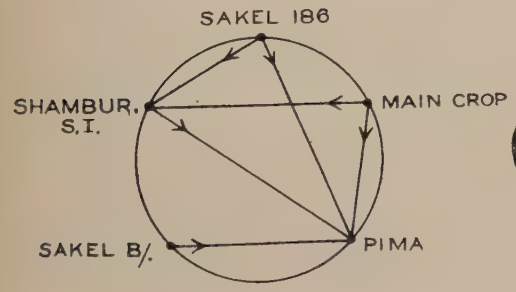
The figures for all three plots were submitted to the process of analysis of variance, all three showing highly significant variances due to differences between varieties.

The variance due to soil differences was very high in the case of the Barakat plot, but not quite equal to that due to varietal differences.

The varieties were compared in pairs on the basis of the residual variance, and the results are shown diagrammatically below, using the system explained in the introductory part of this section.

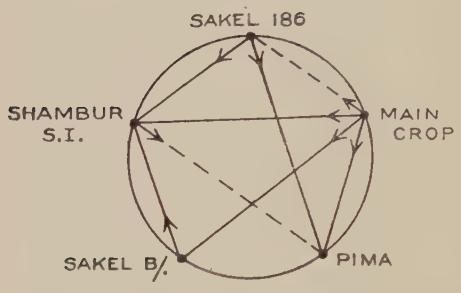


SHAMBAT.



(Conclusions doubtful owing to irregularities in stand.)

BARAKAT.



WAD MEDANI.

Ginning out-turn figures are available only for the Shambat plot which was ginned at the Section's ginnery.

The averages (for all pickings) came out as follows :—

	Per Cent.
Sakel 186/24	31·7
Sakel B/24	31·5
Gezira Main Crop	32·0
Shambur Sakel I.	29·3
Pima	31·5

The most important of the developmental observations refer to the degree to which the varieties were affected by Blackarm and leaf curl diseases.

The plots were visited towards the end of November by Mr. Massey, who gave " marks " to the individual beds representing the heaviness of infection by Blackarm, 7 marks representing an extremely severe attack.

The results are tabulated below :—

		Wad Medani.	*Barakat.*
Average of five beds.	Sakel 186/24	2·8	2·6
	Sakel B/24	3·2	2·6
	Gezira Main Crop	3·1	2·5
	Shambur Sakel I.	2·4	1·9
	Pima	5·2	4·0
Single beds only.	Garofallou	3·5	—
	Bolland 19.3	2·2	2·0
	Shambur Sakel III.	—	1·6

The great susceptibility of Pima and the relative resistance of Shambur Sakel I, and, probably, of Shambur Sakel III and Bolland Sakel 19.3 are well shown.

We are indebted to Mr. Lambert for the following record of the incidence of leaf curl on the Medani plot.

Variety.	*No. of Plants Examined.*	*Nil Infection.*	*Slight Infection.*	*Medium. to Severe.*
		%	%	%
Sakel 186	150 (in 5 beds) ...	12·7	8	79·3
Sakel B/24	160 „ „ ...	1·3	8·1	90·6
Gezira Main Crop ...	144 „ „ ...	3·5	8·4	88·1
Shambur S.I. ...	175 „ „ ...	**64·6**	27·4	**8·0**
Pima	131 „ „ ...	10·7	22·1	67·2
Garofallou	31 (1 bed only) ...	9·7	9·7	80·6
Sakel Bolland 19.3...	88 (2 beds only)...	**29·6**	10·2	**60·2**

The high degree of resistance shown by the Shambur Sakel is well shown, and there is some indication that Sakel Bolland 19.3 is also more resistant that the other types grown. This latter type, together with one of the Shambur Sakels will be included in the standard variety tests in the coming season.

Other developmental observations made at Shambat and Wad Medani are of considerable interest. These refer to the rate of node development and the position on the main stem at which the lowest sympodium is produced. The varieties showed considerable differences in these respects and the two sets of observations made at different stations confirmed each other in almost every case. The results may be summarised as follows :—

Pima.—Much the slowest in node development rate, but this is compensated for as regards earliness of crop production by the very low position (about 8th axil) in which the first fruiting branches are borne.

Shambur Sakel I.—Next slowest in node development, but second lowest in position of fruiting branches (about 10th axil).

Sakel 186.—Slightly slower in node production than other true Sakels, but lowest sympodium tends to appear rather lower (about 12th axil).

Sakel B/24.—Slightly quicker than Sakel 186 in node development. Lowest sympodia a shade later (12—13th axil).

Gezira Main Crop.—The quickest in node development rate. Lowest sympodium position as in Sakel B/24. The above results, as regards the last three varieties named, agree closely with those obtained in previous years.

Other features of interest which emerged from plot observations were the slight tendency to monopodial branching shown by Pima, and the relatively short growth of Shambur Sakel I.

Very little evidence could be found in the present season's results for the direct effect of node-rate or sympodial position or yields, but the lowness of the fruiting zone in Pima appeared to be directly connected, at Shambat, with the heavy early yields given by this variety there.

(B) *I.* American Cotton. Line Test.

This test was carried out in a very similar manner to that outlined in the case of the "Egyptian-type" Line Test, except that, owing to lack of space, only one row of "control" variety was sown alongside each test-row for comparison.

Similar precautions were taken in the matter of cutting out plants in order to get an equal number of plants in the test rows and their respective control rows.

Very little seed was available in several cases, and this, combined with bad germination, caused the stand to be very irregular—to such an extent that no two varieties could be regarded as having been grown at the same spacing. This must have affected both the flower production and final yield very considerably, and it would be unfair to place any reliance at all on any differences in yield except the most extreme.

The "control" type was the local "Pump Scheme Strain"—a particularly strong growing type, but not really suitable for this purpose on account of the large proportion of rogue-plants which it contains, which causes it to be very irregular.

The highest yield in the plot was given by X.A.728, a selection made at this station from Pump Scheme strain. This type yielded 116%, taking the yield of the control type as 100, the two lowest yielders in the plot being "Webber 49 Strain 2" and "Cokers Delta Webber No. 5" which both gave yields of only 50.5%.

The other types which seemed to show promise of giving satisfactory yields were Delta Webber (commercial), "Parnells A.12", "Gendettu" (a selection from Pump Scheme Strain) and X.A.2728, a selection from Columbia, which is referred to at more length in the section of this report dealing with results from the breeding and propagation plots.

"Parnells U.4" and two strains of cotton from Uganda ("S.G.15" and "S.G.26") did not show up particularly well under these conditions.

Parnells A.12 and U.4 were both characterised by decidedly high ginning out-turn. Other types which were distinctly satisfactory in this respect were X.A.03528 (a relatively short-linted selection from Meade) and X.A.728, which has been noted above as the highest yielder in the plot.

Observations were made on the amount of " Leaf-Curl " infection on these rows, but the attack in general was so light that the results are probably not very reliable. It is interesting to note, however, that Parnells U.4 showed indications of being one of the most resistant types in the plot, thus confirming last year's observations.

Records were made in all cases of boll-weight, number of loculi, seeds per boll and seed weight, and photographs were taken of typical plants in each row. Parnells A.12 stood out very conspicuously amongst the rest as having the highest number of seeds per loculus (8.3) and the highest number of loculi per boll.

(B) *II.* American Varieties (Standard Series) Irrigated Plots.

(i) Shendi.

(ii) Moeis.

The results from these plots for the season under consideration are very meagre.

Both plots were sown in early July under favourable conditions and should have done well, but the Moeis plot was later submerged by the exceptionally high Nile which overflowed its banks, and the Shendi plot was stripped of all its leaves and young bolls by an invasion of locust hoppers during the period August 17th—26th.

The damage to the Moeis plot was irreparable, and the plot had to be abandoned. The Shendi plot recovered in time, but the yields finally obtained do not represent the normal yielding power of the varieties, but only the capacity of those types to recover after complete defoliation and removal of early crop. Under such circumstances Pump Scheme strain, with its normal tendency to form strong late growth did much better than any of the other types.

The actual yields obtained were as follows :—

Shendi.

Average yield for whole plot = 951 rottles per feddan.

Varieties.	*Mean Bed Yield.*
Pump Scheme	165·3
Wild's No. 1	122·8
Delrect I.	113·1
Uganda S.G. 15	101·9
Webber 49 Strain 2	91·0

As the locust attack was even over the whole plot, the results given above are reliable for the special circumstances under which they were obtained. Pump Scheme, under these circumstances, gave a significantly higher yield than any of the others; Wilds No. 1 was significantly higher than the last two varieties and Delrect significantly higher than Webber 49 which gave the lowest yield of all.

(B) *III.* American Varieties (Standard Series) Rain Grown Plots.

(i) Talodi. }
(ii) Kadugli. }
(iii) Bueda. }
(iv) Fau. }
(v) Yei. }
(vi) Kagelu. }

A general description of these plots has already been given at the head of this section, in which their relation to the development of rain-grown cotton in the Sudan was touched on. The Nuba Mountains District (represented by our plots at Talodi and Kadugli) continues to give the most promising results and expansion there has been very rapid. The yield from this district has increased from 30 bales (500-lb. bale) in 1924/25 to approximately 9,000 bales in 1929 30.

Variety test plots have now been grown for four years in succession at Talodi and Kadugli.

All the six plots in this series were laid out in an identical manner as regards size, shape, varieties used and number of replications. Each plot was three feddans in area, and was divided into 27 equal strips of which the two end strips were used as protective belts, whilst the remaining 25 strips were divided into five blocks, giving five repetitions of each variety. The position of the varieties within the blocks was "balanced", otherwise the arrangement of varieties was "at random."

The varieties grown were the same as at Shendi, *i.e.* :—

Pump Scheme.
Wilds No. 1.
Delrect I.
Uganda S.G.15.
Webber 49, Strain 2.

The "belt beds" at Talodi and Kadugli were sown with Uganda S.G.26, those at Bueda and Fau with old-type Delta Webber and those

at Yei and Kagelu with Pedigree Dixie, in order to obtain rough indications as to the behaviour of these varieties in those districts.

The following details relate to individual plots :—

Talodi.—Same site (Talodi Experimental Farm) as in 1927/28. Sown June 13th. Resown July 6th. Thinned and spaced on July 17th and 21st. Final spacing 90 × 75 cms. Land had been ploughed twice since last crop and was surface-cleaned four times between June–October. The soil was a light, rather loamy cotton soil, brown in colour, fairly even except in the case of beds 1–3, where it was harder, resulting in a noticeable stunting of the plants there without, however, any clear effect on the yield. The rainfall from May–November was 806 mms., evenly distributed.

Germination was good and stand very regular. The plants grew strongly and well and gave very high yields. Blackarm was fairly severe during the wet weather and Boll-worm did a fair amount of damage at the end of the season.

Kadugli.—A new site this year. Sown June 29th and resown on August 1st. Thinned and spaced on August 11th and 15th. Final spacing 90 × 75 cms. The land was surface cultivated four times between June and October but was not ploughed prior to sowing. The soil was a light brown cotton-soil, similar to that at Talodi, but harder, especially in the lower layers and decidedly more impervious both to roots and moisture than the soil at Talodi. Beds 1 to 3 were decidedly stunted compared with the rest of the plots, and the whole of the first block of variety beds showed reduced yields. The yield gradient at this end was, however, sufficiently even to permit of the system of corrections based on yields of adjacent beds being applied. The rainfall from May to October was 764 mms., and was much less evenly distributed than at Talodi, a much higher proportion falling *before* the sowing date in this case.

The stand of plants obtained was very even indeed, but growth was less vigorous and less prolonged than at Talodi, as might be expected from the conditions outlined above, and the final yield though satisfactory (950 rottles per feddan) was only $\frac{2}{3}$rds of the excellent crop obtained at Talodi.

Blackarm was less in evidence than at Talodi, but Pink boll worm was decidedly bad and contributed to the reduction in crop. Stainer bug was not really serious at either of these stations.

Bueda.—Sown July 3rd. Resowing was not required as the germination and final stand of plants were excellent, individual beds not varying by more than 3 per cent. Thinned and spaced on August 18th and early September. The soil was heavy black cotton soil, containing about 70% of clay and with p.H. = 8·4. It was very even and regular throughout the whole plot, as judged by the growth of the plants. The rainfall from mid-June to the end of October was 600 mm., and was thought to be heavier than normal.

Growth was satisfactory from the start, but finished off earlier than in the Nuba Mountains district, as was to be expected in view of the shorter rainy season.

Blackarm was present but developed rather late (end of September) and did very little damage. The final crop (1,200 rottles per feddan) was unexpectedly high for this type of country.

Fau.—Sown July 7th. Resowing not required as germination and final stand were excellent. Thinned and spaced August 28th and early September, the final

spacing being the same as at Bueda. The surface was kept weeded throughout, as at Bueda. The soil was very similar indeed to that of the Bueda plot, but a little less dark in colour. It was very even throughout the plot. Rainfall mid-June–early October was 570 mms.—rather less than Bueda.

Growth was less vigorous and more curtailed than at Bueda and the final crop only about one half.

Yei.—Sown July 19th. Resown August 8th. Thinned and spaced on August 14th and 26th. Final spacing 90 × 100 cms. Weeds grew strongly but were kept in hand by hoeing six times. The soil was quite different in character to that in either the Nuba Mountains or Gedaref district. The top 6 ins. to 12 ins. was a greyish sandy loam, overlying a reddish sandy loam passing to a red laterite gravel at about 3 feet. Plenty of roots were found in the top 3 feet and some as low down as 6 feet. The soil is slightly alkaline in reaction (p.H. 7·48). Local irregularities occurred, due to the removal of tree stumps and ants' nests, but these were scattered about in an even manner. Rainfall during the growing period, mid-July–end December only, was about 700 mm. (The *total* for the year in this district is about 1,400 mm.)

The growth of the plants was peculiar—rather stout and lax, medium height (about 120 cms.) with shortish sympodia and rather much "vegetative" branching. Shedding of buds and bolls was very heavy and continuous, resulting in a very low yield and a long-drawn-out picking period.

The cause of this shedding is difficult to determine. Blackarm had been rather bad during the first three quarters of the plant's history but it did not appear to have been any more severe than at, say, Talodi where big yields were obtained. Boll-worm and Red bug did considerable damage, but most of the shedding had occurred before they could get to work. It is thought that the most likely cause of such wholesale shedding lies in the cloudy overcast weather which had prevailed with only slight interruption since the sowing date. Previous experience has shown that heavy shade can produce a very marked shedding-response in cotton, and experiments are being carried out in the coming season to test this explanation.

Kagelu.—Sown July 16th. Resown July 30th. Thinned and spaced on August 13th and 24th as at Yei. The soil and other conditions, such as the incidence of pests, etc., were very similar to those at Yei, but the rainfall for the period mid-July to end of December was heavier (840 mms.). Germination and stand were very even.

Growth was of the same type as at Yei but shedding even more pronounced, otherwise the same remarks apply.

The final yields from all these six plots and the probable corrections to be applied are given in the following table, together with the average ginning out-turn (in percentages) for each variety at each place and the calculated yield of lint, based on the recorded ginning out-turns and on the *corrected* weights of seed cotton.

YIELDS FROM AMERICAN COTTON (RAIN GROWN) VARIETY TESTS, 1929/30.

Varieties.	Talodi. Average net Yield per feddan = 1,502 rottles.			Kadugli. Average net Yield per feddan = 954 rottles.			Bueda. Average net Yield per feddan = 1,184 rottles.			Fau. Average net Yield per feddan = 598 rottles.			Yei. Average net Yield per feddan = 230 rottles.			Kagelu. Average net Yield per feddan = 299 rottles.		
	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.	Uncorrected Yields.		Probable Corrections.
	Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.		Rottles per Bed.	Order of Yield.	
Pump Scheme Strain	156·6	1(=)	−0·2	92·8	4	+1·3	117·2	3	−5·2	55·6	5	+0·1	21·4	2	+0·3	28·3	2(=)	−0·7
Wild's No. 1...	151·5	3	−0·6	93·6	3	+0·3	121·1	1	+0·1	63·1	1	−0·4	17·0	5	−0·3	21·0	5	+0·1
Delrect I.	141·2	5	+1·4	83·2	5	+3·4	115·7	4	+2·2	60·2	2	+0·8	20·5	3(−)	+0·5	28·3	2(=)	−0·2
Uganda S.G. 15	156·7	1(=)	−4·4	104·5	1	−0·9	119·8	2	+2·8	59·2	3	+0·3	24·7	1	−0·5	30·5	1	+0·4
Webber 49 Strain 2	142·8	4	+3·3	101·5	2	−4·5	112·5	5	−0·9	56·7	4	−0·3	20·5	3(=)	−0·1	25·5	4	+0·6

GINNING OUT-TURNS (*average for all pickings*), LINT YIELDS (*based on G.O.T.'s and "Corrected" Yields*) and ORDER OF MERIT.

	G.O.T.	Lint Yield perbed.	O.M.	G.O.T.	Lint Yield perbed.	O.M.	G.O.T.	Lint Yield perbed.	O.M.	G.O.T.	Lint Yield perbed.	O.M.	G.O.T.	Lint Yield perbed.	O.M.	G.O.T.	Lint Yield perbed.	O.M.	G.O.T. Average for Variety.
Pump Scheme Strain	27·6	43·1	2	27·1	25·5	1	28·7	32·1	4	29·4	16·4	3	26·8	5·81	2	27·1	7·47	1	27·7
Wild's No. 1	30·1	45·3	1	26·6	25·0	2=	30·1	36·4	1	31·4	19·7	1	26·1	4·36	5	24·0	5·06	5	28·1
Delrect I.	28·7	40·9	4	27·0	23·3	4=	29·0	34·2	2	30·0	18·3	2	27·6	5·79	3	26·5	7·44	2	28·0
Uganda S.G. 15	23·7	36·0	5	22·5	23·3	4=	27·0	33·1	3	27·0	16·0	4=	24·6	5·95	1	22·2	6·86	3	24·3
Webber 49	28·2	41·2	3	25·8	25·0	2=	28·5	31·8	5	28·5	16·1	4=	27·0	5·51	4	25·6	6·76	4	27·2
Average for Station	27·7	—	—	25·8	—	—	28·7	—	—	29·3	—	—	26·4	—	—	25·1	—	—	—

The (uncorrected) yields of seed cotton from all these plots were examined by the method of analysis of variance.

The variance due to varietal differences *as a whole* was found to be of significant proportions at Kadugli, Fau, Yei and Kagelu. Analysable variance due to soil heterogeneity was significant at Kadugli, Bueda. Yei and Kagelu.

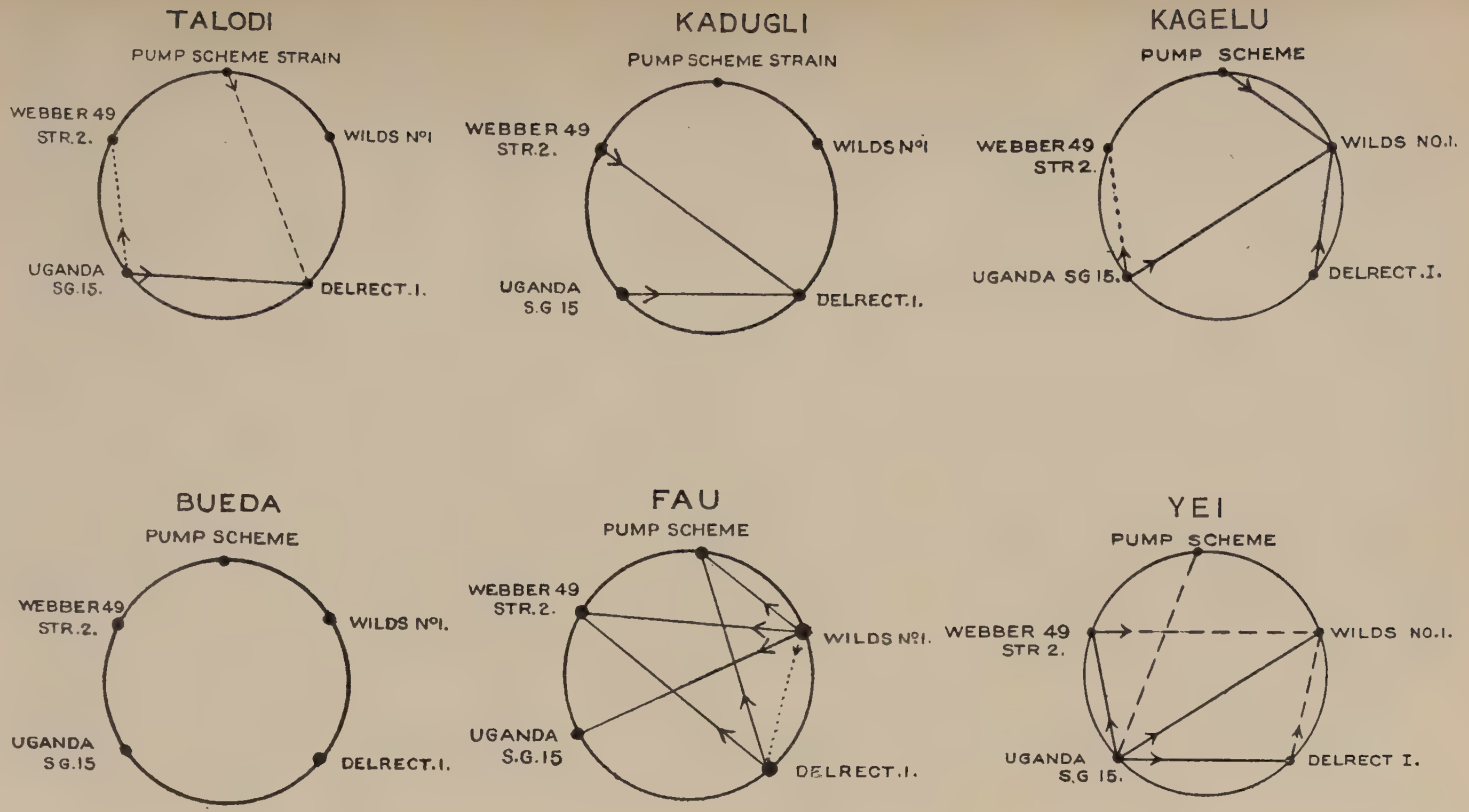
When the varieties were compared in pairs, on the basis of the difference between the variances due to their different yielding powers and the residual variance in each case, it was found that some only of the varietal differences could be regarded as significant.

The result of these comparisons is shown diagrammatically on the opposite page (the significance of lines joining the points on the circles is explained at the beginning of this section of the report).

Inspection of the tables etc., given above, shows the very high position taken by *Uganda S.G.*15 in the matter of yield of seed-cotton, in which it heads the list in four cases out of six. This result is, however, heavily discounted by the *exceptionally low ginning out-turn*, which actually reduces it to bottom place in three cases. The variety is early, which is a character in its favour for rain-cultivation in the Sudan, but the staple, on the other hand, is too long to be dealt with successfully by saw-gins and the variety has, when grown formerly in Uganda, been reported on unfavourably by the Spinners in the matter of waste and neppiness. In view of these drawbacks, and as the yield of *ginned* lint is relatively low, this variety will not be given further trial in the rain-area, but may eventually prove very useful on the northern Pumping Schemes, grown under irrigation. As regards susceptibility to Blackarm attack it appeared to show some slight resistance. It is a tall-growing vigorous variety, but not quite so strong as Pump Scheme, to which it is related. It is decidedly inclined to lodge and rather liable to shed. It produces rather a lot of vegetative branches, but not as much as Pump Scheme.

Wilds No. 1, on the whole, gave the best results in the more northerly plots, and has a satisfactory ginning out-turn. In Mongalla, however, it did poorly, giving the lowest yields both of seed-cotton and lint. It appeared to be definitely susceptible to Blackarm, and taken on the whole was the worst of the varieties tried in this respect. This is a serious drawback, and for the present it has been decided to keep this type in reserve, merely building up a nucleus supply of pure seed, until other competitors have been tried out. It is a short-growing variety with very few vegetative branches, rather lacking in vigour, but satisfactorily erect in growth.

Webber 49, *Strain* 2 gave definitely the poorest results over the whole


TALODI
PUMP SCHEME STRAIN
WEBBER 49 STR.2.
WILDS Nº1
UGANDA SG.15.
DELRECT.I.
KADUGLI
PUMP SCHEME STRAIN
WEBBER 49 STR.2.
WILDS Nº1
UGANDA S.G 15
DELRECT.I.
KAGELU
PUMP SCHEME
WEBBER 49 STR 2.
WILDS NO.1.
UGANDA SG 15.
DELRECT.I.
BUEDA
PUMP SCHEME
WEBBER 49 STR.2.
WILDS Nº1.
UGANDA SG.15
DELRECT.I.
FAU
PUMP SCHEME
WEBBER 49 STR.2.
WILDS Nº1.
UGANDA S.G.15
DELRECT.I.
YEI
PUMP SCHEME
WEBBER 49 STR 2.
WILDS NO.1.
UGANDA S.G 15.
DELRECT I.

range, except for an isolated success at Kadugli, where it took second place for yield, both of seed-cotton and lint. This general result is confirmed by its behaviour in a series of " observation plots " (see later) in Southern Mongalla, where, out of seven varieties, it gave the lowest yield in three cases out of four.

The quality of the lint is decidedly good, but as it is very similar to, and no better than that of Delta Webber and Delrect, there seems to be no reason for growing it in preference to the latter.

It is a short-growing Webber-type cotton, erect in habit and with very few vegetative branches.

It was very variable in its behaviour as regards Blackarm.

Delrect I gave disappointing results in the Nuba Mountains district, but when allowance is made for its relatively high ginning out-turn, it gave about the best all-round performance in the Gedaref and Mongalla districts.

In Gedaref its most serious competitor was Wilds No. 1, but, as explained above, this variety has shown itself rather too liable to Blackarm for general use.

In Mongalla, with the exception of Uganda S.G.15, which has already been dealt with, Delrect was only beaten by Pump Scheme.

Preliminary reports from the Graders indicate that Delrect is at least equal to Delta Webber in quality, so that it is permissable to take the valuations given for Pump Scheme and Delta Webber in 1928/29 as a basis for comparing the cash return per unit area likely to be obtained for these two varieties. The valuations then given were 10.35d. per lb. for Delta Webber and 10.1d. for Pump Scheme, both grown in the Nuba Mountains. On this basis Delrect would give a slightly better return per acre than Pump Scheme in this district. It is possible that the difference might really be more decidedly in favour of Delrect, as indications were obtained this year that the staple of Pump Scheme strain is liable to deteriorate considerably in the extreme south.

Delrect is a short-growing type, moderately erect, with few vegetative branches. It was found to be rather resistant to Blackarm at Talodi and in Southern Mongalla, as compared with the other types grown in these trials.

Pump Scheme Strain.—This, which is the standard type of the country, gave, on the whole, about the best results in the Nuba Mountains test plots, but did relatively poorly in Gedaref and was surpassed, on the basis of return per unit area, by Delrect in Mongalla.

The success of this variety at Talodi this year is almost certainly connected with the prolonged growing and cropping period, which are

reflected in the very high yields obtained there from all varieties. Under such circumstances Pump Scheme Strain, which tends to produce the bulk of its crop rather late, is able to show its powers to the full, as it does when grown under irrigation, and is undoubtedly very hard to beat. In other less favourable seasons, and especially, when grown under native cultivation this variety would be relatively handicapped.

Similar considerations doubtless operated at Kadugli where the growing season was still of considerable duration though the final yield was less.

In Gedaref the growing season was too short for this variety to make any real progress, and the very favourable conditions for early development favoured the earlier varieties.

None of the varieties grown in the "*belt beds*" showed signs of outstanding success. *Uganda S.G.*26 (Talodi and Kadugli) was at both stations rather later than the other varieties and gave a lower final yield. *Delta Webber* (old-style) at Bueda was early and gave distinctly good yields, but was favoured by soil conditions. At Fau this type was about as early as Delrect, though not as early as Uganda S.G.15. It gave a slightly higher final yield than Delrect.

Pedigree Dixie (Yei and Kagelu) gave about an average result in the earlier pickings, but fell off in the later pickings, giving a lower final yield than the others. It appeared to show some slight degree of resistance to Blackarm, but was not otherwise satisfactory.

The variation in ginning out-turn given by the different varieties at the different stations, referred to in last years report, is again a matter of interest.

The figures from the irrigated plot at Shendi will not be dealt with in detail owing to the abnormal conditions under which the crop was grown this season. For the rain-grown trials, Gedaref district gave the highest figures, followed by the Nuba Mountains district, Mongalla giving the lowest results.

The falling-off in ginning out-turn as the season progresses, noted last year in the case of rain-grown plots, is shown very well again at Kadugli. At Talodi the general tendency was in the same direction, but the curves all tended to rise again for the latest pickings, a result probably associated with boll-worm or possibly due to the roots reaching a lower stratum of damper soil. The same general trend was shown at Bueda, but at Fau (where only three pickings were taken) it did not appear.

Yei and Kagelu gave quite irregular results, different varieties behaving in different ways; Wilds No. 1 and Pump Scheme both tended to rise from early to later pickings, but other varieties showed no clear tendency in any direction.

On the whole, the view, advanced last year, that low soil moisture content is associated with low ginning out-turn is confirmed, except in the case of the Mongalla plots, where other factors are probably at work.

5. Grader's and Spinning Tests.

These tests were carried out during the course of 1929 on samples submitted by us from the crop grown here in 1928/29. Full particulars as to the yields and other relevant data obtained from these crops will be found in *last year's report.* (E.C.G.C. "Reports received from Experiment Stations 1928-1929").

The grading and valuation of all the samples referred to here were carried out by Messrs. Wolstenholme and Holland, to whom we owe a great debt of gratitude in view of the very large number of samples (94) with which they most kindly dealt.

Spinning tests were carried out either through the Shirley Institute or by the Experimental Department of the Fine Cotton Spinners' and Doublers' Association, to both of which institutions and to the individual spinning firms who co-operated with the former, we take this opportunity of expressing our great indebtedness.

In considering the results given below it is worth while remarking that it is usual in this country to take pickings at fortnightly intervals. Irrigated cotton usually gives 7 or 8 pickings. Rain grown cotton may be expected to give from 2 to 6 pickings according to the rainfall.

(*a*) *Egyptian-type Cottons from the Breeding Plot and Propagation Plots at Shambat* (1928-29 *Crop*).

The samples sent under this heading included the following:—

(i) From Breeding Plot. ...	Whole-season pickings from Family 14/28. Whole-season pickings from Family 43/28.
(ii) From Propagation Plot.	Samples drawn from 3rd to 6th pickings, mixed, of a type of Sakel known as "*Sakel Bolland* 19.3" and of three new kinds of long-staple cotton designated "*Shambur Sakel II*", "*Shambur Sakel III*" and "*Shambur Sakel IV*."

The two samples from the Breeding Plot were both very small and were, of necessity, very mixed in staple owing to the inclusion of very late pickings which are always very short and inferior in quality.

These two samples are, however, interesting in view of the fact that the former is a much modified form of the old Afifi cotton, and the latter is a strain of pure Sea Island cotton which has proved to be particularly vigorous and fruitful in this locality. The two strains were crossed in 1928 and promising results have been obtained.

The grading results are summarised in the Table below. " F.G.F. " Sakel on the day of testing was quoted at 14.95d. and " Good " Sakel at 15.75d.

The samples were placed in grades ranging from " About good " to " Fully fine ". The valuations given have all been " corrected " in order to represent what the samples might have been expected to realise if they had all been classed as " Good Sakel ".

Variety.	*Staple (inches).*	*Valuation (pence per lb.).*	*Remarks.*
14/28	$1\frac{3}{16}$	—	*Uppers* character. Light brown. Strong. Wanting in fineness and lustre.
43/28	$1\frac{5}{16}$	15·85	Sakel character. Light brown. Wasty. Medium strength. Lustrous and fine.
Sakel Bolland 19.3 ...	$1\frac{3}{8}$–$1\frac{7}{16}$	15·80	Sakel character. Strong. Fairly lustrous and fine.
Shambur Sakel II. ...	$1\frac{3}{8}$–$1\frac{1}{2}$	16·60	Sakel character and colour. Rather irregular. Strong. Fairly lustrous and fine.
Shambur Sakel III. ...	$1\frac{7}{16}$–$1\frac{1}{2}$	17·35	Sakel character and colour. Strong. Very lustrous and fine.
Shambur Sakel IV. ...	$1\frac{7}{16}$–$1\frac{1}{2}$	16·70	Sakel character and colour. Strong. Lustrous and fine.
" Good " Sakel	—	15·75	—

The sample of 14/28 was valued on an Uppers basis, and was given a premium of 55 points over Uppers of same grade.

The three Shambur Sakels and the sample of Bolland Sakel 19.3 were subjected also to spinning tests.

The following Table shows the total waste, and the count by strength products, obtained by the lea test on yarns spun to 100's count, with different twist factors and in twofold.

Variety.	Total Waste %.	Strength by Count.			
		Singles.			Twofold.
		2·6 T.F.	3·18 T.F.	3·6 T.F.	2·6 T.F.
Bolland Sakel 19.3	21·8	1970	2100	2210	3520
Shambur Sakel II.	25·4	2060	2260	2340	3840
Shambur Sakel III.... ...	23·2	2050	2370	2410	3750
Shambur Sakel IV.... ...	25·6	1800	2040	2050	3380

The relatively high waste percentages given by the Shambur Sakels are without doubt partly due to the inclusion in the sample of cotton from the 5th and 6th pickings.

(*b*) *Egyptian-type Cottons from Preliminary Variety Test, Shambat Experimental Farm* (1928-29).

The varieties grown in this test are precisely the same as in 1927-28, except that Shambur Sakel I takes the place of " B.B.B. ", to which it is, however, very closely related.

The samples, which are all considered to fall within the Sakel class, ranged in Grade from " Fully Good " to " Fully Fine ". The valuations given by the grader have all been brought, in the Table which follows, to the basis of a common grade of " Good Sakel."

" F.G.F." Sakel on the day of examination stood at 14.95d. and " Good " Sakel at 15.75d.

Variety.	Staple (inches).	Valuation (pence per lb.).	Remarks.
Shambur Sakel I.	1½	16·85	Sakel colour. Strong. Lustrous and fine.
S.I.D. 1.8	1⅜–1 7/16	16·55	Fair colour. Strong. Lustrous and fine.
S.I.D. 14.1	1 5/16–1⅜	15·80	R/r brown (for Sakel). Very strong. Lustrous. Mod., fine.
Massey's Selected Domains	1 5/16–1⅜	15·40	Brown (for Sakel). Strong. Fairly lustrous. Wanting in fineness.
S.I.A. 2.7	1⅜–1 7/16	16.40	About Sakel colour. Strong. Lustrous, but rather wanting in fineness.
S.I.D. 3.2	1 7/16	16.30	Fair colour. Strong. Lustrous, but wanting in fineness.
Garofallou	1 5/16 (irreg.)	15·40	Fair colour. Strong. Rather wanting in fineness and lustre.
Shambur Sakel I. (with 5 extra waterings).	1½	17·30	Sakel colour. Strong. Lustrous and fairly fine.
" Good " Sakel	—	15·75	—

The high position taken by Shambur Sakel I and S.I.D. 1.8, confirms last years results. Extra water given to the Shambur Sakel I seems to have had a good effect on the quality.

Massey's Selected Domains and Garofallou, as in previous season have been given a low price, but, as usual, Garofallou did extremely well in the spinning tests, as will be seen later.

Spinning tests were carried out at the same counts and with the same series of twist factors as in the case of the samples from the Breeding and Propagation plots (V.S.).

The results are shown diagrammatically in Fig. 2 (see next page).

The following order for " general utility " is given by the Fine Cotton Spinners Experimental Section in reporting on these yarns :—

1. Garofallou.
2. S.I.D.1.8.
3. S.I.D.14.1.
4. Massey's Selected Domains.
5. S.I.D.3.2.
6. Shambur Sakel I.
7. S.I.A. 2.7.

S.I.D. 1.8 thereby shows itself for the third time to be a satisfactory type of cotton, and Garofallou again succeeds in producing remarkably little waste and in giving a thoroughly good strong yarn, despite its low valuation.

Shambur Sakel I gives a higher percentage waste than any of the others, but the figure is not excessively high as was the case with the related " B.B.B." last year.

(c) *Egyptian-type Cottons from the Standard Variety Tests at Shambat and Wad Medani* (1928-29).

The varieties tested were the following :—

Bolland Sakel 8 Sakel 186 Massey's Selected Domain Main Crop Gezira (Tokar Seed) Sakel B/24 Nahdah	Grown, both at Shambat and at Wad Medani, in Test plots with 5 replications.
Shambur Sakel I. S.I.D. 3.2 Afifi-derivative A.143.7.9	Grown in single belt-beds at Wad Medani. Grown in single belt-bed at Shambat.

All the samples were from 3rd pickings except the last, which was a mixture of 2nd and 3rd pickings.

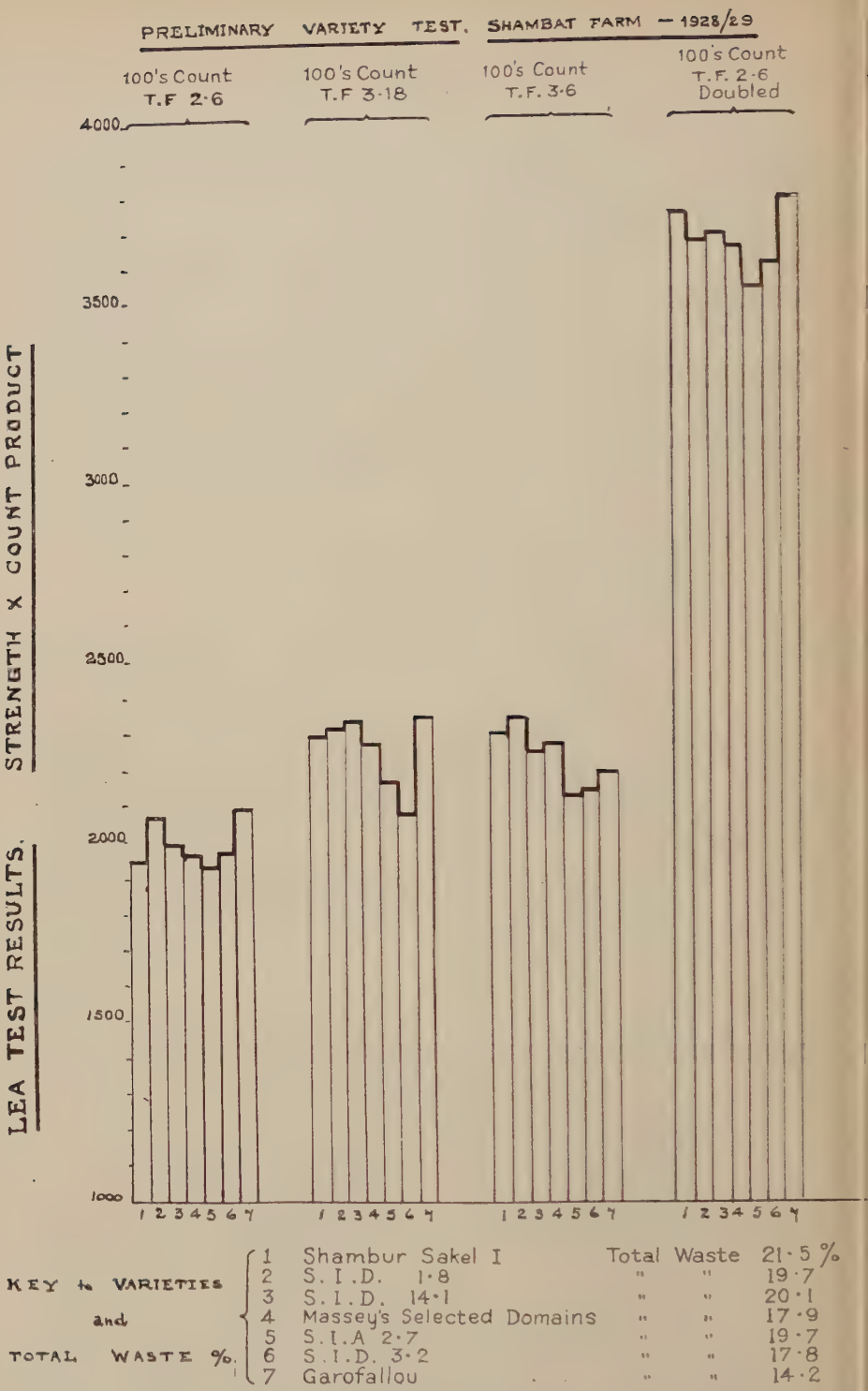

PRELIMINARY VARIETY TEST. SHAMBAT FARM — 1928/29
100's Count T.F 2·6
100's Count T.F 3·18
100's Count T.F. 3·6
100's Count T.F. 2·6 Doubled
LEA TEST RESULTS. STRENGTH X COUNT PRODUCT
4000
3500
3000
2500
2000
1500
1000
1 2 3 4 5 6 7
KEY to VARIETIES and TOTAL WASTE %
1 Shambur Sakel I Total Waste 21·5 %
2 S.I.D. 1·8 " " 19·7
3 S.I.D. 14·1 " " 20·1
4 Massey's Selected Domains " " 17·9
5 S.I.A 2·7 " " 19·7
6 S.I.D. 3·2 " " 17·8
7 Garofallou " " 14·2
All are "composite" samples, drawn from 3rd picking only

Fig. 2.

The first six varieties on the list have now been tested for three years in succession.

With one exception (Nahdah, at Shambat, which was classed as "Good") all the samples were placed in grades ranging from "Fully Good" to "Fine".

In the following Table the valuations have all been reduced to a basis of "Good Sakel" in order to make them more comparable.

The official quotation for "F.G.F. Sakel" on the day of examination was 14.95d., "Good Sakel" being approximately 15.75d.

The samples of Nahdah and of "A.143" were valued on a different basis from the others and are, therefore, not comparable with the others. The actual valuations in these cases were :—

Nahdah (Shambat)—graded "Fully Good" at price of 13.00d.

Nahdah (Gezira)—graded "Good" at price of 12.25d.

A.143 (Shambat)—graded "Fully Good" at price of 14.95d.

"Good" Pelion, on the nearest quoted date, stood at 12.25d.

		Shambat.	Wad Medani.
Bolland Sakel 8	Valuation	15·15d.	15·55d.
	Staple ...	$1\frac{1}{4}''$–$1\frac{5}{16}''$ (irregular)	$1\frac{3}{8}''$–$1\frac{7}{16}''$ (mixed with short)
	Strength	Strong	Strong
	Remarks	Browner than normal. Wanting in fineness and lustre.	Much browner than normal. Fine and lustrous.
Sakel 186	Valuation	14·9d.	15·15d.
	Staple ...	$1\frac{1}{4}''$ (irregular)	$1\frac{1}{4}''$-$1\frac{5}{16}''$(much mixed with short)
	Strength	Medium	Medium
	Remarks	Higher colour than normal. Wanting in fineness and lustre.	Rather browner than normal. Wanting in fineness and lustre.
Massey's Selected Domains	Valuation	15·15d.	15·40d.
	Staple ...	$1\frac{5}{16}''$	$1\frac{5}{16}$–$1\frac{3}{8}$ (wasty)
	Strength	Strong	Strong
	Remarks	Browner than normal. Wanting in fineness and lustre.	Much browner than normal. Fairly fine and lustrous.
Main Crop Gezira (Tokar Seed)	Valuation	14·9d.	15·55d.
	Staple ...	$1\frac{1}{4}''$–$1\frac{5}{16}''$ (wasty)	$1\frac{3}{8}''$ (rather wasty)
	Strength	Medium	Strong
	Remarks	Browner than normal. Coarse and wanting in fineness and lustre.	Browner than normal. Lustrous and fine.
Sakel B/24	Valuation	15·9d.	15·65d.
	Staple ...	$1\frac{3}{8}''$	$1\frac{3}{8}''$ (mixed with short)
	Strength	Strong	Strong
	Remarks	Rather browner than standard. Fairly lustrous and fine.	Browner than normal. Fairly fine and lustrous.

		Shambat.	Wad Medani.
Nahdah	Valuation	(*see text*)	(*see text*)
	Staple ...	$1\frac{1}{4}''$	$1\frac{1}{4}''$ (wasty)
	Strength	Strong	Medium
	Remarks	Deep brown. Rather wanting in fineness and lustre.	Deep brown. Moderately fine. Rather wanting in lustre.
Shambur Sakel I	Valuation	—	16·70d.
	Staple ...	—	$1\frac{3}{8}''$–$1\frac{7}{16}''$ (rather wasty)
	Strength	—	Medium to Strong
	Remarks	—	Light Sakel colour. Fairly lustrous and fine.
S.I.D.3.2	Valuation	—	16·30d.
	Staple ...	—	$1\frac{3}{8}''$–$1\frac{7}{16}''$
	Strength	—	Medium to strong
	Remarks	—	Slightly browner than normal. Lustrous and fine.
A.143.7.9	Valuation	(*see text*)	—
	Staple ...	$1\frac{5}{16}''$	—
	Strength	Very strong	—
	Remarks	Light brown. Lustrous, but wanting in fineness.	—

With the exception of Shambur Sakel I and S.I.D. 3.2. the valuations received are all disappointing. Sakel 186. grown at Wad Medani. in this case gets the lowest valuation, though when the same series was grown there in 1926-27 it was given the highest place.

The improvement in quality when the same cotton is grown at Wad Medani. compared with its performance at Shambat is well shown in this Table.

The brownness of all the samples needs comment. It would appear that darkening in colour takes place very readily in these samples owing to their small bulk and the ease with which the air can penetrate them before they are baled-up.

Only those samples grown at Wad Medani. together with the sample of "A.143" from Shambat. were submitted to spinning tests. The results are shown diagrammatically in Fig. 3.

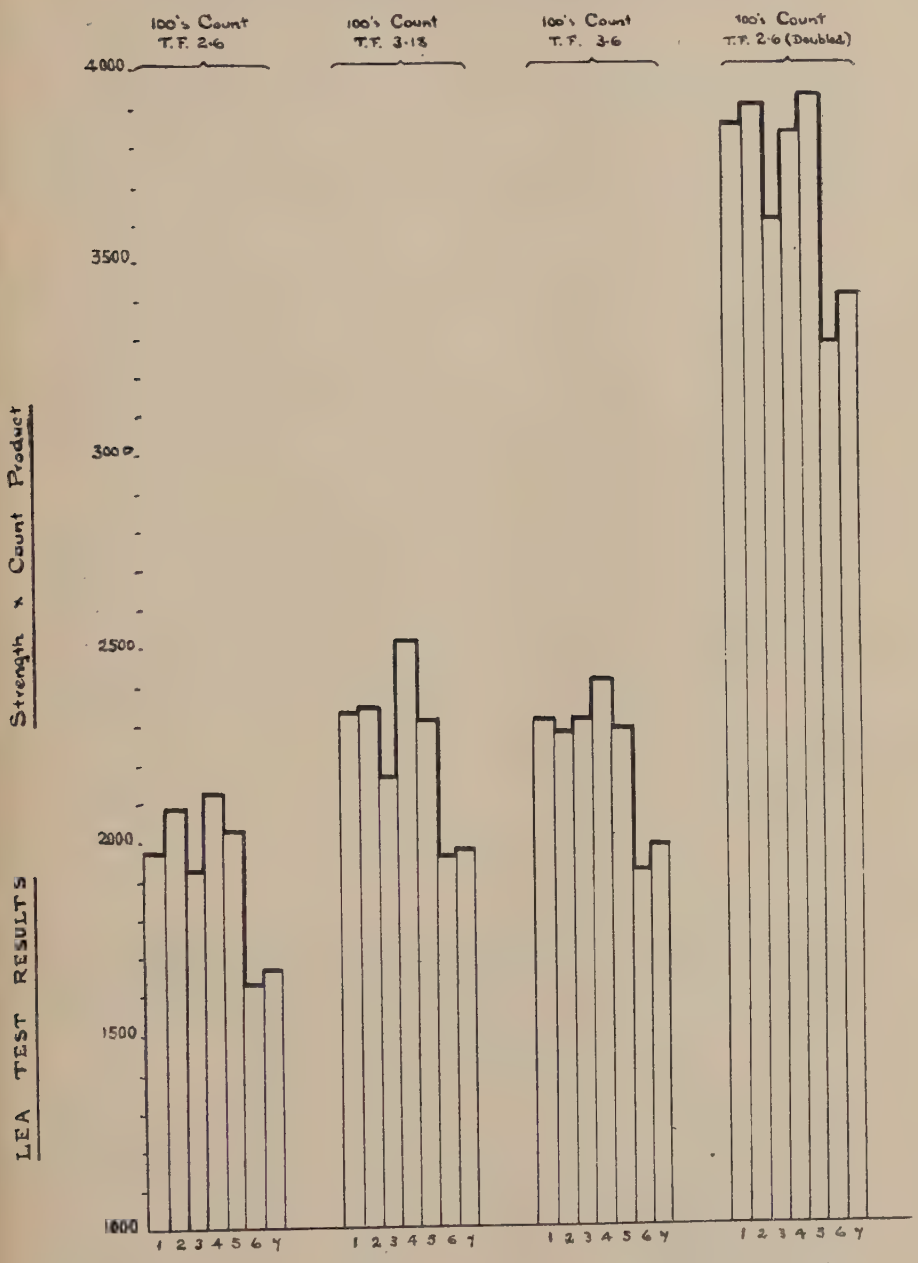
These tests were carried out on exactly the same basis as those performed on the varieties from the Preliminary Variety Test (see above) and the results can be compared directly with the latter.

The order of "general utility" given in this case was as follows :—

1. Main Crop.
2. Sakel 186.
3. Sakel B/24.
4. Bolland Sakel 8.
5. Massey's Domains.
6. Nahdah.
7. A.143.

EGYPTIAN VARIETY TEST — WAD MEDANI 1928/29

and a sample of an Afifi derivative ("A.143·7·9") grown at Shambat



Key to Varieties and Total Waste %

		Total Waste
1	Bolland Sakel 8	20·8 %
2	Sakel 186	20·9
3	Masseys Selected Domains	22·4
4	Main Crop Gezira	21·2
5	Sakel B/24	20·9
6	Nahdah	21·0
7	Afifi derivative (A 143·7·9)	21·9

All are "composite" samples drawn from 3rd picking only, except No. 7. which is from 2nd and 3rd pickings (mixed) from a single bed.

Fig. 3.

A curious feature of these spinning-test results is that Bolland Sakel 8 and Massey's Selected Domains have together given the poorest results, whilst these two types, when last submitted for spinning from the same farm and associated with the same other varieties, gave decidedly the best lea-test results. Sakel 186 has for the second time given satisfactory spinning results, though on the present occasion surpassed by the Main-crop sample.

Out of a total of twenty four samples sent to the Fine Cotton Spinners' Experimental Mill at Bollington from the above tests and other sources, the first four in the "General order of Merit", as given in the Spinning Report, were (1) Garofallou, from Preliminary Variety Test, Shambat; (2) Main Crop Gezira from Variety Test, Wad Medani; (3) S.I.D. 1.8 from Preliminary Variety Test, and (4) Sakel 186 from Variety Test, Wad Medani.

The twenty-four samples included, in addition to those already dealt with in the present and preceding sections, representative samples of Gezira cotton grown and ginned by the Sudan Plantations Syndicate. These samples were classified into the customary grades employed by the Syndicate, the two highest grades included in the series being marked "S" and "X.S.S." respectively. In the "General order of Merit" referred to above, the "S" sample was placed 5th, whilst the "X.S.S." sample was placed 13th.

(*d*) *American Cottons from the Breeding Plot and Propagation Plots at Shambat* (1928-29 *Crop*).

List of samples submitted:—

(i) From Breeding Plot ...	Whole-season picking from Family A.16/28. Whole-season picking from Family A.24/28. Whole-season picking from Family A.27/28.
(ii) From Propagation Plots	Coker's Delta Webber No. 6 (Mid-early pickings). Coker's Wilds No. 1 (Early and mid-season pickings). Uganda S.G. 15 (Second picking). Uganda S.G. 26 (Second picking). Delrect I. (Shendi) (Mid-early pickings).

Of the above, A.16/28 represents a new type selected out of Meade cotton, differing from the original in being relatively early and less liable to shed; A.24/28 is a re-selection from the strain growing in the Breeding Plots, which has given rise to the sub-type now known as "Delrect"; A.27/28 is a new type selected from Columbia, and characterised by great vigour and fruitfulness and a much lessened tendency to shed. All these three kinds are being muliplied-up in 1929/30 with a view to trial on a large scale. Their behaviour in the present test is not really representative, in view of the fact that the samples were very small and contained a lot of end-crop.

The remaining types include " Delrect I ", now being propagated for distribution on a large scale, and four new introductions from abroad, two of which came from Coker's Pedigreed Seed Company in the U.S.A. and two from Uganda.

The grader's reports on these types are summarised in the Table which follows.

The samples varied in classification from " Strict Middling " to " Strict Good Middling ", but in the Table all valuations have been recalculated to show the expected price if all samples had been of the same grade of Strict Good Middling.

The quotation for Middling American on the day of examination was 9.87d., and for Strict Good Middling was 10.67d.

The highest valuation has been given to the Uganda cotton " S.G. 15 ", and it is probable that this might be a very valuable cotton for growing on the Pump Schemes North of Khartoum, though experience in Uganda has shown that it is not suitable for growth under rainfall only.

Delrect I has also been given a very satisfactory premium. This is the type which it is hoped to distribute in the near future to the rain-cotton areas.

Variety.	*Staple.*	*Valuation.*	*Remarks.*
A. 16/28	1 3/16"	12.60d.	Rather wasty. Strong. Lustrous and fine.
A. 24/28	1 1/8" full	11·35d.	(Stained.) Medium to strong. Wanting in lustre and fineness.
A. 27/28	Full 1 1/8"–1 3/16"	11·85d.	(Stained.) Medium to strong. Fairly lustrous and fine.
Wilds No. 1	1 3/16"	12·75d.	Strong. Creamy. Rather wanting in fineness and lustre.
Delrect I.	1 3/16"	13·00d.	Good colour. Strong. Fairly lustrous and fine.
Coker's No. 6	About 1 3/16"	12·50d.	Good colour. Medium to strong. Fairly lustrous and fine.
Uganda S.G. 15	Good 1 3/16"	13·75d.	Good colour. Strong Fairly lustrous and fine.
Uganda S.G. 26	Barely 1 3/16"	12·70d.	Fair colour. Medium strong. Rather wanting in fineness and lustre.
Strict Good Middling American	—	10·67d.	—

The results of spinning tests on the last four samples in the above list are shown diagrammatically in Fig. 4.

The relatively high count to which all the samples have been spun and the choice of Abassi as a " control " indicates the high standard of quality of all these cottons. The performance of Uganda S.G.15 under the Lea Test is especially noteworthy.

In appearance, the finished yarns gave the following order of merit : (1) Control ; (2) Cokers No. 6 ; (3) Delrect I ; (4) S.G.15 ; (5) S.G.26.

All yarns were stated to be level and very satisfactory.

(*e*) *American Cottons from the Standard Variety Tests (Irrigated and Rain-grown)*, 1928-29.

A very complete series of samples from these tests was sent home for spinning and grading.

These samples cover a wide range of conditions varying from the practically arid climate of the Northern Sudan (where they were grown under irrigation), through definitely unfavourable conditions of light rainfall (18 inches) and heavy cotton-soil in Fung Province, to the more suitable conditions found in the Nuba Mountains district (Talodi and Kadugli) where the soil is more loamy in character and the annual rainfall reaches 30 inches and upwards.

The *same five varieties were grown in all different situations* and the samples were in all cases taken from the early part of the crop, so as to be as comparable as possible.

The effect of " locality " on the quality of cotton is a matter of wide general interest, and we have, therefore, attempted in Fig. 5 to show graphically the changes which have taken place, as reflected in the graders' reports.

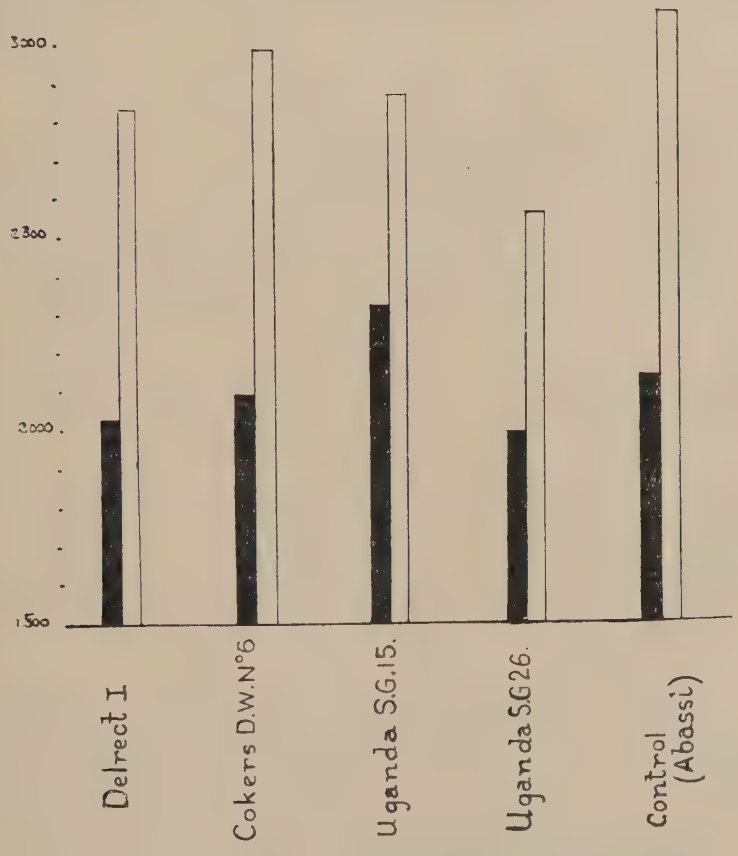
If all the results from the five different stations are shown separately, the diagrams become too confusing. We have, therefore, " averaged " the results from the two stations in the Northern Sudan (Shendi and Moeis) and also the results from the two stations in the Nuba Mountains (Talodi and Kadugli), in so far as it is possible to take an average of, for instance, two records of " Grade " or of " degree of Fineness " etc.

It is realised that the " distances " allowed in these diagrams between the different grades are purely arbitrary, but, as long as this fact is borne in mind, the diagrams should help to show up the differences more clearly than would otherwise be possible.

It is interesting to note how decidedly the Grade, Staple Strength and value fall away with diminishing water supply. Lustre and

AMERICAN PROPAGATION PLOTS 1928/29

((all samples spun to 75^s twist (combed))



Shewing Strength x Count products for different varieties

Note { Results of LEA Tests indicated by Black Columns
Results of BALLISTIC " " " White "

		%
Scutcher and Card Waste %	Delrect I	9·5
	Cokers No 6	8·4
	Uganda S.G. 15	9·4
	Uganda S.G. 26	10·9
	Control	10·7

Fig. 4.

fineness, however, behave in the converse way, due no doubt to an increasing proportion of thin-walled, partly immature hairs.

Fig. 5, in addition to showing the effect of environment on the quality of the cotton, also shows the relative position of the varieties tested as regards valuation, staple-length etc.

Spinning tests were carried out only on the samples from Talodi and Ghati.

The results of these are shown in Figs. 6 and 7. Unfortunately, no direct comparison can be made between the results obtained from the two areas owing to the wide difference in counts to which the two series were spun, but this difference itself indicates clearly enough the very much poorer quality of the cottons from the water-starved Ghati plot.

The total waste is shown in Fig. 7 but not in Fig. 6. A comparison of the two localities in this respect gives the following result :—

	Talodi (Roller gin).	*Ghati (Roller gin).*
	Per cent.	*Per cent.*
Delta Webber	13·8	9·3
Webber 10	10·9	12·7
Pedigree Dixie	12·1	13·0
Pump Scheme	12·4	8·8
Webber 38	12·1	14·7

An interesting feature of this season's results is the good performance of Pump Scheme Strain in the Lea Tests, and, to a less extent, in the Ballistic Tests. This does not accord with the previous season's results. The relatively poor position taken by Pedigree Dixie is in agreement with earlier experience. This variety has since been dropped out of the Standard Variety Test series.

Another point of great importance is dealt with in these tests, and that is the effect on the lint of *saw-ginning as compared with roller ginning.*

Each of the five samples from Talodi, representing the five different varieties was subdivided, after mixing thoroughly, and one half was ginned on a roller gin, the other being saw-ginned.

The effect as regards spinning properties is shown diagrammatically in Fig. 7, whilst in Fig. 8 (p. 257) we have attempted to summarise pictorially the Graders' judgments.

No definite trend in either direction can be shown to exist in the matter of yarn-strength or total waste (Fig. 7), but the resulting yarns

AMERICAN COTTON VARIETY TESTS — 1928/29.

GRADERS OPINIONS and VALUATIONS

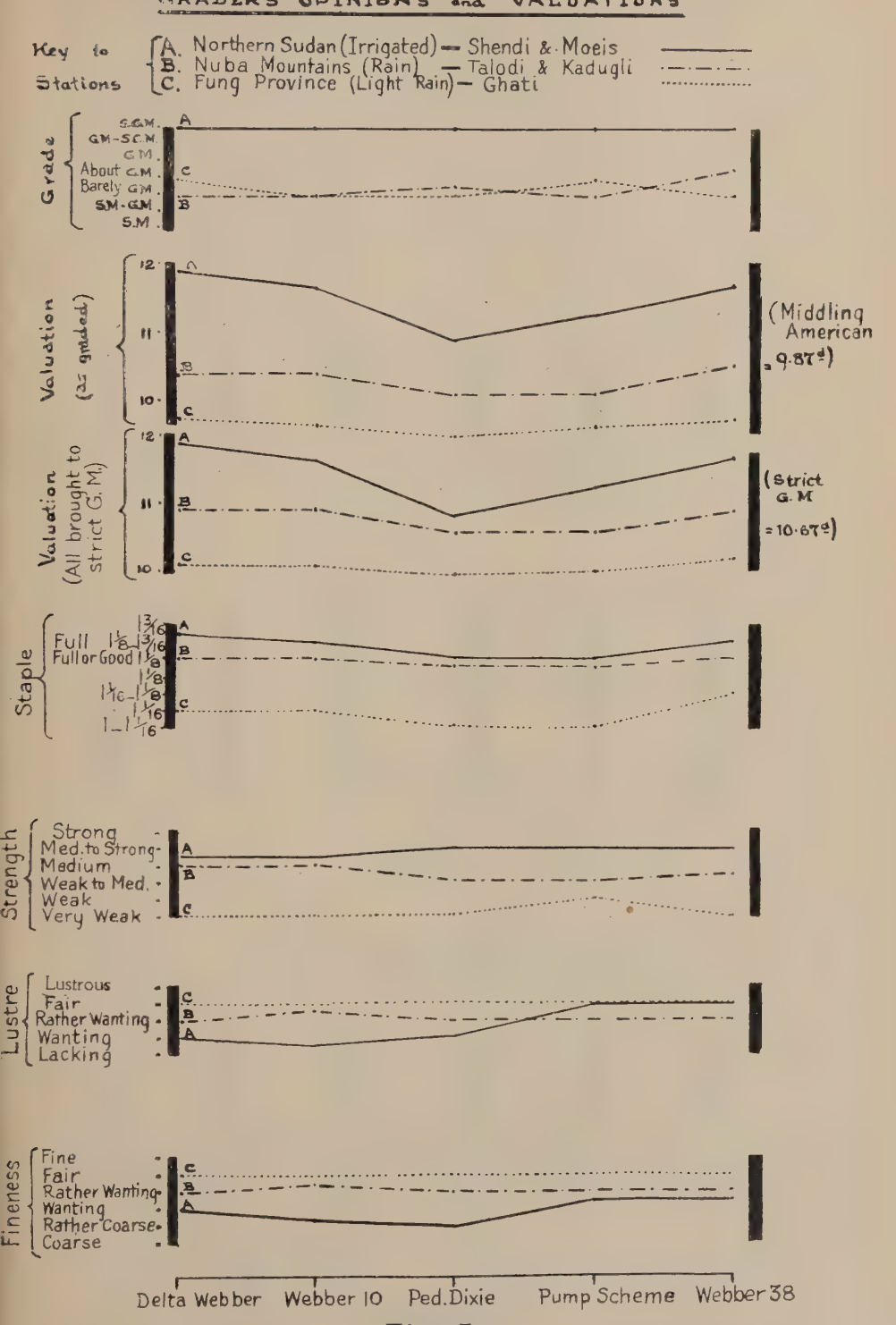


Fig. 5.

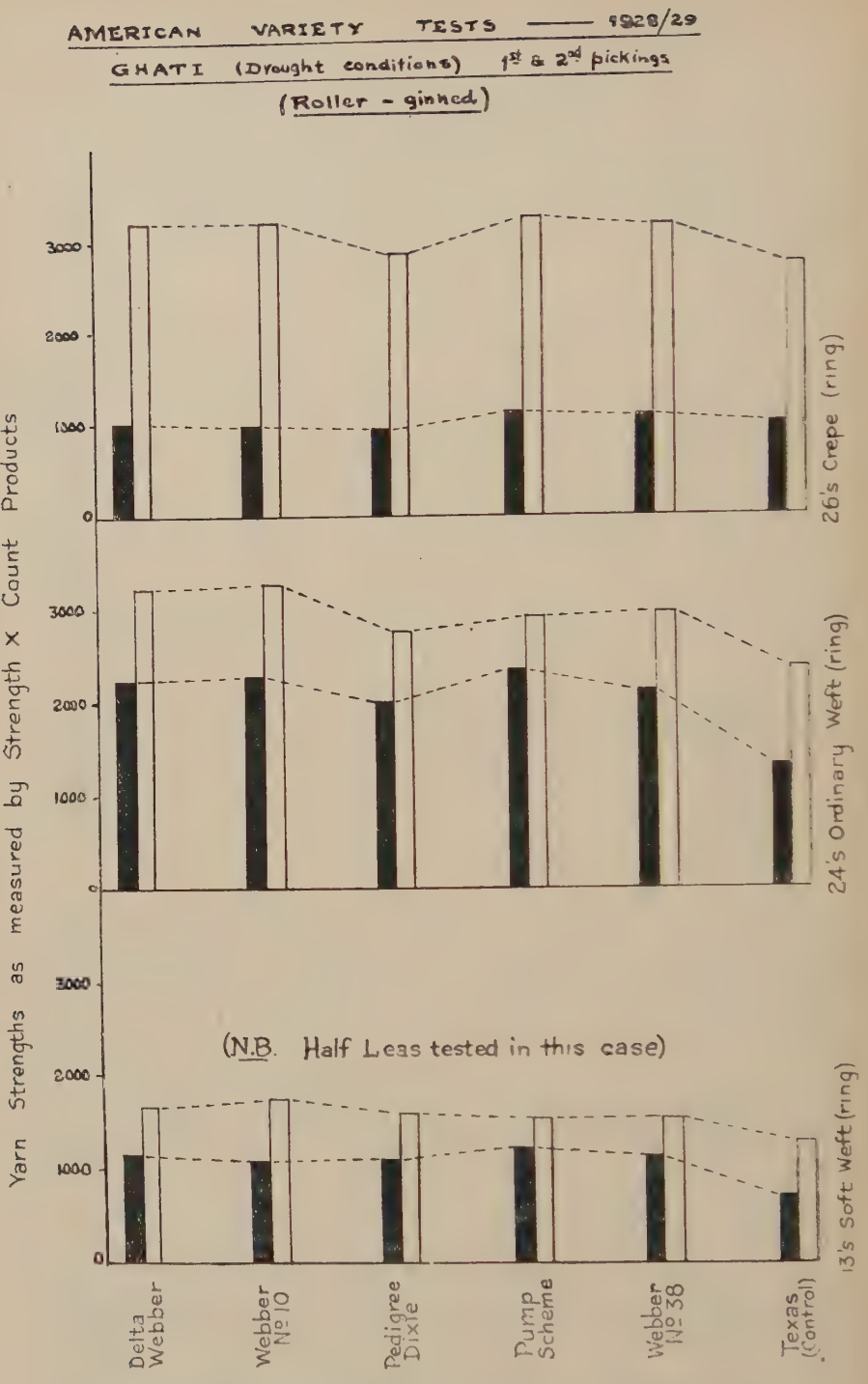

AMERICAN VARIETY TESTS —— 1928/29
GHATI (Drought conditions) 1st & 2nd pickings
(Roller - ginned)
Yarn Strengths as measured by Strength x Count Products
3000
2000
1000
0
26's Crepe (ring)
24's Ordinary Weft (ring)
13's Soft Weft (ring)
(N.B. Half Leas tested in this case)
Delta Webber
Webber No 10
Pedigree Dixie
Pump Scheme
Webber No 38
Texas (Control)
Note { Results of Lea Tests indicated by Black Columns
Results of Ballistic " " " White "

Fig. 6.

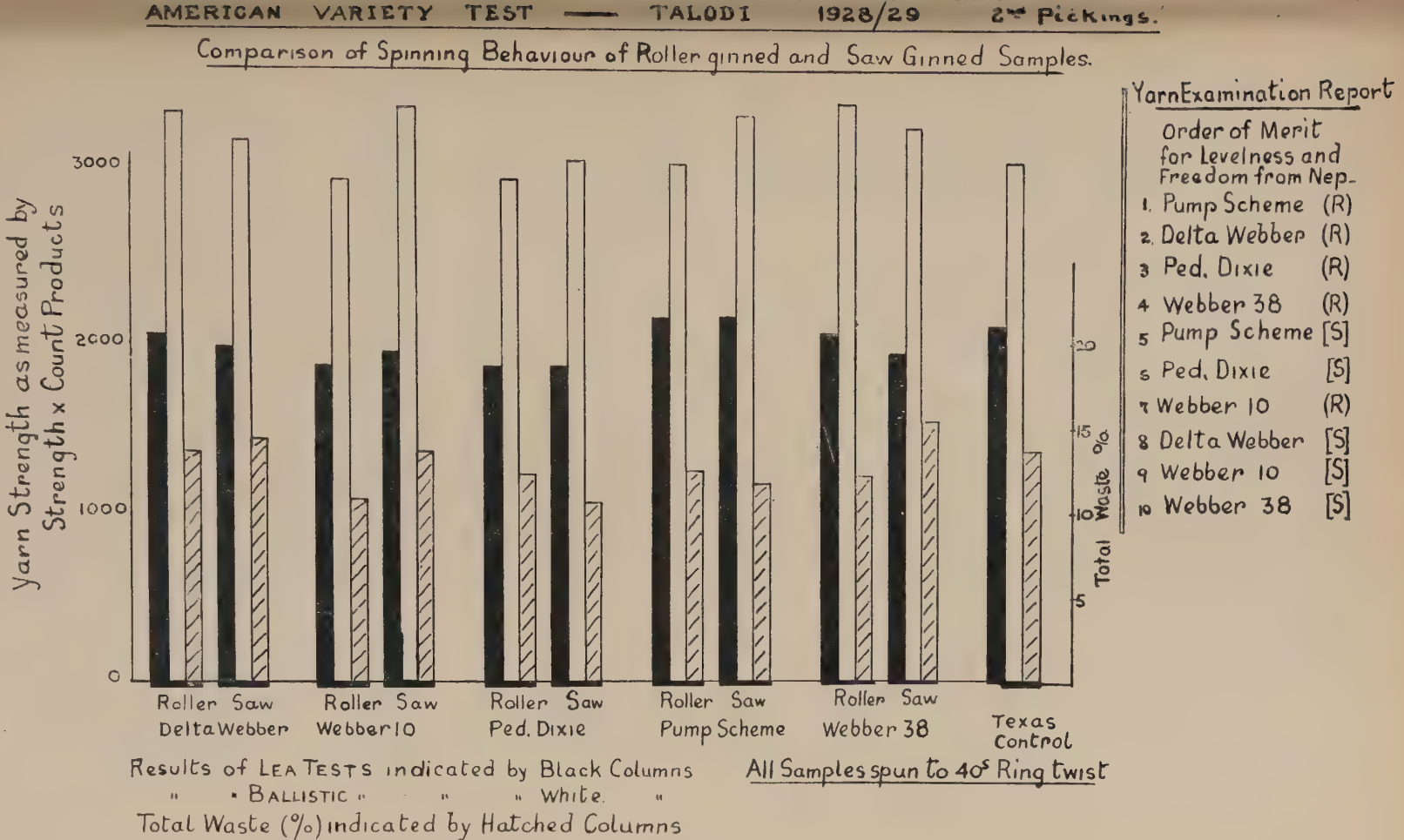

AMERICAN VARIETY TEST — TALODI 1928/29 2nd Pickings.
Comparison of Spinning Behaviour of Roller ginned and Saw Ginned Samples.
Yarn Examination Report
Order of Merit for Levelness and Freedom from Nep.
1. Pump Scheme (R)
2. Delta Webber (R)
3 Ped. Dixie (R)
4 Webber 38 (R)
5 Pump Scheme [S]
6 Ped. Dixie [S]
7 Webber 10 (R)
8 Delta Webber [S]
9 Webber 10 [S]
10 Webber 38 [S]
Yarn Strength as measured by Strength x Count Products
3000
2000
1000
0
20
15
10
5
Total Waste %
Roller Saw
Delta Webber
Webber 10
Ped. Dixie
Pump Scheme
Webber 38
Texas Control
Results of LEA TESTS indicated by Black Columns
" " BALLISTIC " " " White. "
Total Waste (%) indicated by Hatched Columns
All Samples spun to 40s Ring twist

Fig. 7.

were stated to be more level and free from nep in the case of the roller-ginned sub-samples. The Graders' judgments, on the other hand, show very clear differences. The colour and grade are "improved" in almost all cases by saw-ginning, but the staple-length, strength and valuation all show a strong tendency to drop.

In addition to the samples dealt with above, three others, grown in "belt" beds of variety tests in the Rain-cotton areas were also submitted. Two of these represented "Lone Star", grown respectively at Talodi and Ghati. The report was not particularly favourable in either case. The third sample was a sample of "Meade" cotton grown in one of the belt-beds at Talodi. This sample was stated to have a staple length of $1\frac{3}{16}$" to $1\frac{1}{4}$", and to be lustrous and fine, and was valued at 13.50. This relatively high value was, however, completely off-set by the very poor yield as recorded in last year's report.

(*f*) *Dates of Sowing Experiment* (*Sakel*) *at the Gezira Research Farm, Wad Medani.*

Samples from this experiment were submitted for Grading and Spinning Tests, through this Section, from the 1926-27 and 1928-29 crops.

The results of the tests have turned out to be very interesting, and it is hoped that they will be published separately in detail.

It may however be noted here that with sowing dates ranging from July 22nd to September 22nd, there is very strong evidence of a deterioration in quality of the lint from the earlier to the later pickings in all cases, and, further, there is evidence that the early pickings from late sowings are not, on the whole, equal in quality to the early pickings of earlier sowings.

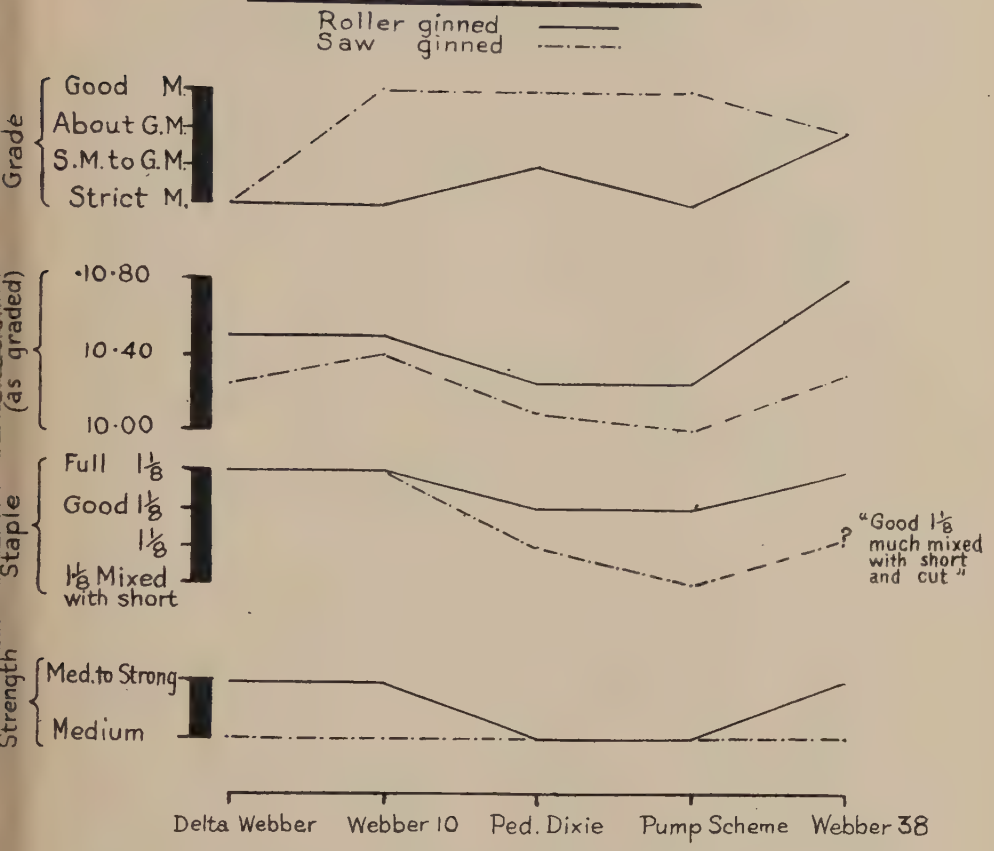
In the case of the 1928-29 results, the grading and spinning results ran very closely parallel, but in the previous series (1926-27) the grading results showed clearly the general trend indicated above, whilst the spinning results did not conform in any way.

6. Developmental Observations.

(*a*) *Routine observations* on the growth and fruiting of plants on the Shambat Farm were carried out as in previous years. The most important conclusion from these, namely that the cold weather experienced during the winter had prolonged very considerably the period of boll-maturation but had not otherwise adversely affected the growth of the plants, has already been set down in the introductory Section of this report.

Comparison between Roller ginned and Saw ginned samples from TALODI VARIETY TEST 1928/29

Graders Opinions and Valuations



Lustre, Fineness, Nep and Colour.

All samples were considered to be the same as regards lustre and fineness, except that Roller ginned Delta Webber, Webber No 10 and Pump Scheme were described as "dull".
All the saw-ginned samples were found to be "neppy"

Differences in colour produced by ginning

	Roller-ginned	Saw-ginned
Delta Webber	slightly stained	dull, fair colour
Webber 10	" "	fairly bright, creamy
Ped. Dixie	high colour	creamy
Pump Scheme	slightly stained	"
Webber 38	creamy	"

Fig. 8.

(*b*) *Special observations on Shedding.*—A shedding trough fixed between two rows of plants in a field of "Massey's Domains Sakel" (Belt bed of the Preliminary Variety Test), was used to collect the sheddings. Bud-shedding was found, as in previous years, to be a much more important factor in determining the crop than boll shedding. A very close agreement was found to exist between the more pronounced "hollows" in the flowering curve and the periods of high bud-shedding, allowing for the necessary interval of time for development of the bud up to the open flower stage.

All buds which fell off were classified according to size. The approximate ages of buds of various sizes having been previously determined, it was possible to prepare a theoretical curve showing all the buds which had dropped, as if they had fallen when 1—2 mm. wide (measured across the bracteoles).

The curve thus produced showed a very close inverse fit with the flowering curve for the same plants with a shift of 25 days, and on adding the two curves together, the irregularities in the flowering curve were to a great extent smoothed out.

The plants behaved quite differently from those which were kept under observation in a similar way in the abnormal season of 1928-29. In that year, bud-shedding had reached almost maximal proportions as early as September 25th and, with minor fluctuations, continued at a high level until about November 20th.

In the present season bud-shedding was negligible until the second week in October and, except for a short period of rather heavy shedding in the second half of October, did not commence to rise seriously until the third week in November. This rise corresponded with the entry of the plants into their first resting stage and was followed, about three weeks later, by the "normal" drop of the flowering curve.

To a considerable extent, the flowering curves for the "shedding-trough plants" corresponded with the flowering curves obtained also in the routine "Observation plot", so that the deductions made may be taken as of general application for the Experimental Farm area. The excellent yields obtained at Shambat this year are reflected in the "normal" shedding curve, shown by our data, just as last year's failure was clearly foretold by the excessive amount of early shedding which occurred in that season.

7. Cotton Experiments in the Southern Sudan. (other than Standard Variety Tests).

At the request of Mr. G. F. March, Senior Inspector of Agriculture for the Southern Provinces, and with the approval of the Director of

Agriculture, we have collaborated with the Agricultural Staff in the carrying-out of certain preliminary experiments in the Southern Provinces.

Plans and detailed instructions for the conduct of these experiments were prepared by the Plant Breeding Section, by whom also arrangements were made for the supply of the material required.

As far as circumstances allowed, the Sudanese staff of this Section were made use of to assist the Agricultural Inspectors in the field and observational work on the plots, and all experiments were inspected by myself during December and January, detailed notes and records being made at the time.

The following experiments were carried out :—

(i) " *Origin of Seed Test* "—Nuba Mountains District.

(ii) " *Dates of Sowing Experiments* "—Mongalla Province.

(*a*) Kagelu (Yei).
(*b*) Torit.
(*c*) Kirrippi (Opari).
(*d*) Kajo-Kaji.

(iii) " *Preliminary Variety Observation Plots* "—Mongalla Province.

(*a*) Torit.
(*b*) Kirrippi.
(*c*) Kajo-Kaji.
(*d*) Meridi.

The following is a very brief summary of the methods employed and results obtained from these experiments :—

(i) *Origin of Seed Test.*

This was carried out at Talodi, using a 3-feddan plot, laid out in strips in exactly the same manner as for a Standard Variety Strip test.

The object of the experiment was to ascertain whether seed supplies grown locally in the Nuba Mountains district gave results in any respect different from those given by seed grown on the northern Pump Schemes and transported to the Nuba Mountains for general sowing.

Two varieties were employed in the test—" Pump Scheme Strain " and " Delta Webber ".

Three lots of *Pump Scheme Strain* seed were available :—

A. " New " seed (newly " imported " from the North Sudan).
B. " One-year-old " seed (grown once previously in Nuba Mountains).
C. " Two-year-old " seed (grown twice previously in Nuba Mountains).

The *Delta Webber* consisted of :—

D. " New " seed (as above).

E. " One-year-old " seed (as above).

Each type of seed was sown in five " replicate " beds, the beds being grouped into blocks and balanced within the blocks, but otherwise arranged at random.

The results obtained are given in the Table, which shows the mean yields per bed obtained, and the yields as corrected on the basis of yields given by adjacent beds.

Variety.	*Kind of Seed.*	*Rottles per Bed.*	
		Yield.	*Corrected Yield.*
Pump Scheme Strain ...	" New "	137·5	138·2
Pump Scheme Strain ...	One year old	141·8	142·4
Pump Scheme Strain ...	Two years old	132·9	133·8
Delta Webber	New	130·4	131·6
Delta Webber	One year old	135·9	132·8

It will be seen that in each case the " one-year-old " seed gave yields slightly, but not significantly, greater than the " New " seed, but that the " two-year-old " seed of Pump Scheme Strain showed a decided drop.

The plot carried a good stand of plants and gave an excellent yield, the growth was, however, rather patchy and irregular.

Observations made in December appeared to show that the plants resulting from " New " seed of Pump Scheme Strain showed less Blackarm infection than those from one or two-year-old seed. This is not unlikely to be the case, in view of the fact that Blackarm is negligible on the Northern Pump Schemes, so that the seed itself would be likely to be free from the parasite. This difference was not, however, apparant between new and one-year-old Delta Webber seed, nor was any difference observed in this respect between the behaviour of one-year-old and two-year-old Pump Scheme Strain seed, despite the difference in yield.

(ii) *Dates of Sowing Test.*

This experiment was carried out on identical lines at all four stations.

Three different varieties were used in the test, namely, Delta Webber (an early, " short period " type) ; Pump Scheme Strain (a late, " long period " type) and " Uganda N.17 ". The last named type was obtained from Uganda, and was included in view of the fact that it had been grown previously for a considerable number of years under conditions which bear a fairly close resemblance to those which obtain in Southern Mongalla. The experiment, therefore, not only demonstrated the reaction of different types of cotton when sown on different dates, but also served to some extent as a preliminary variety test of the three kinds included in the test.

The trial was conducted on a small scale at each station in order to cut down the routine work as far as possible.

Four dates were decided upon in advance, but it was not possible to adhere absolutely strictly to these dates owing to weather conditions. The actual times at which sowings were carried out are shown below :—

	Kagelu.	*Torit.*	*Kirrippi.*	*Kajo Kaji.*
1. Last fortnight in June ...	June 15	June 27	June 19	June 21
2. First fortnight in July ...	July 7	July 13	July 6	July 8
3. Last fortnight in July ...	July 22	July 25	July 21	July 22
4. Last fortnight in August...	August 26	August 7	August 15	August 16

At each date of sowing, three single rows, 70 metres long, of each variety were sown. The varieties were grouped into blocks containing a single row of each variety, and the position of the blocks within the field was arranged at random. The spacing was $1\frac{1}{4}$ metres $\times$ 50 cms.

Two main criticisms may be levelled against this layout—(1) that the later-sown rows would be handicapped by the growth previously made by the earlier sown lots alongside, and, (2), that the earlier-sown lots would act as " nurseries " for Red-bug and other pests which would spread on to the later-sown lots at an early stage in their development. In actual practice, observation showed that neither of these factors had interfered seriously with the result. As has been stated above, each " block " consisted of three adjacent rows sown on the same day. In no case was it possible to say that the two outside rows of the block had suffered from stunting as compared with the central row, which at the time of sowing was distant $2\frac{1}{2}$ metres from the nearest earlier-sown cotton on either side.

Considerable care was taken at sowing and thinning time to get an even stand of plants at correct spacing, and the exact number of surviving plants was counted in each line at picking time. Notes were made on soil irregularities and these were taken into account along with the figures for total plants-per-row in considering the yield-results.

Rain-gauges were installed at all four stations, and daily records kept. No serious period of drought occurred at any station, but the distribution of the rainfall varied widely from place to place. At Kirrippi, August and the first half of September were relatively dry, but very heavy rain fell during the same period at Torit. Torit was also remarkable for a fall of nearly 4 inches in the first week in December, whereas no rain fell at Kajo Kaji during the same period and relatively small amounts at the other two stations.

The total yield per feddan also showed very wide differences from place to place. The earliest sown cotton at Kajo Kaji gave the remarkably high yield of about 1,600 rottles of seed cotton per feddan.

The corresponding sowings at Kirrippi and Torit gave yields of about 1,200 and 700 rottles respectively, whilst that at Kagelu averaged only 250 rottles per feddan.

The plot at Kagelu was influenced by the same adverse conditions which affected the Variety Test there (see earlier section of this report). The yields at Kirrippi and Torit may be taken as representing the kind of crop that may be expected in those districts with careful planting and clean cultivation. The yield at Kajo Kaji is abnormal, and was almost certainly due to the fact that the field was on a rather sharp slope at the foot of a hill. Any excessively heavy rainfall drained off at once, but a supply of underground water would be maintained beyond the end of the rainy season by percolation from the high ground above.

It is surprising, in view of the great differences in variety, site, rainfall-distribution, and final yield of the plots, to find how closely the results agreed for all four stations. In all cases the earlier sowings gave decidedly superior results, the advantage being, perhaps, slightly more obvious in the case of "Uganda" than with the other varieties.

In all but three cases, the Uganda variety surpassed the others in yield at all stations and for all times of sowing. Two of the exceptions were the 1st sowing and last sowing at Kajo Kaji, but these are certainly attributable, at any rate in part, to the rather patchy stand obtained with Uganda seed for those two sowings. The third exception is due partly to the unexpectedly high yield given by Pump Scheme strain in the last sowing at Torit, which can be attributed to the fact that too many plants had been left in the rows in the case of this variety at the final operation of spacing (approximately 17% more plants), and partly to a patch of high ground, the site of a former ant-hill, which directly reduced the yield of the Uganda variety.

The comparison of the results obtained from Delta Webber and Pump Scheme Strain affords no such clear issue. In the case of the two *later* sowings, Pump Scheme, contrary to expectation, appears to have the advantage at almost all localities. The indications given by this experiment, however, are strongly in favour of *early* sowings, and if we allow for the fact that Delta Webber has a slightly higher ginning out-turn and is distinctly superior in staple, we find that, in the case of the first two sowings, Delta Webber has given the more satisfactory results in six cases out of eight, the two exceptions being the first sowings at Kajo Kaji and Kirrippi.

The results for all four stations are shown graphically in the accompanying diagram (Fig. 9).

FINAL YIELDS

Final Yields at four Stations of three different varieties sown at four different dates during the season —1929/30

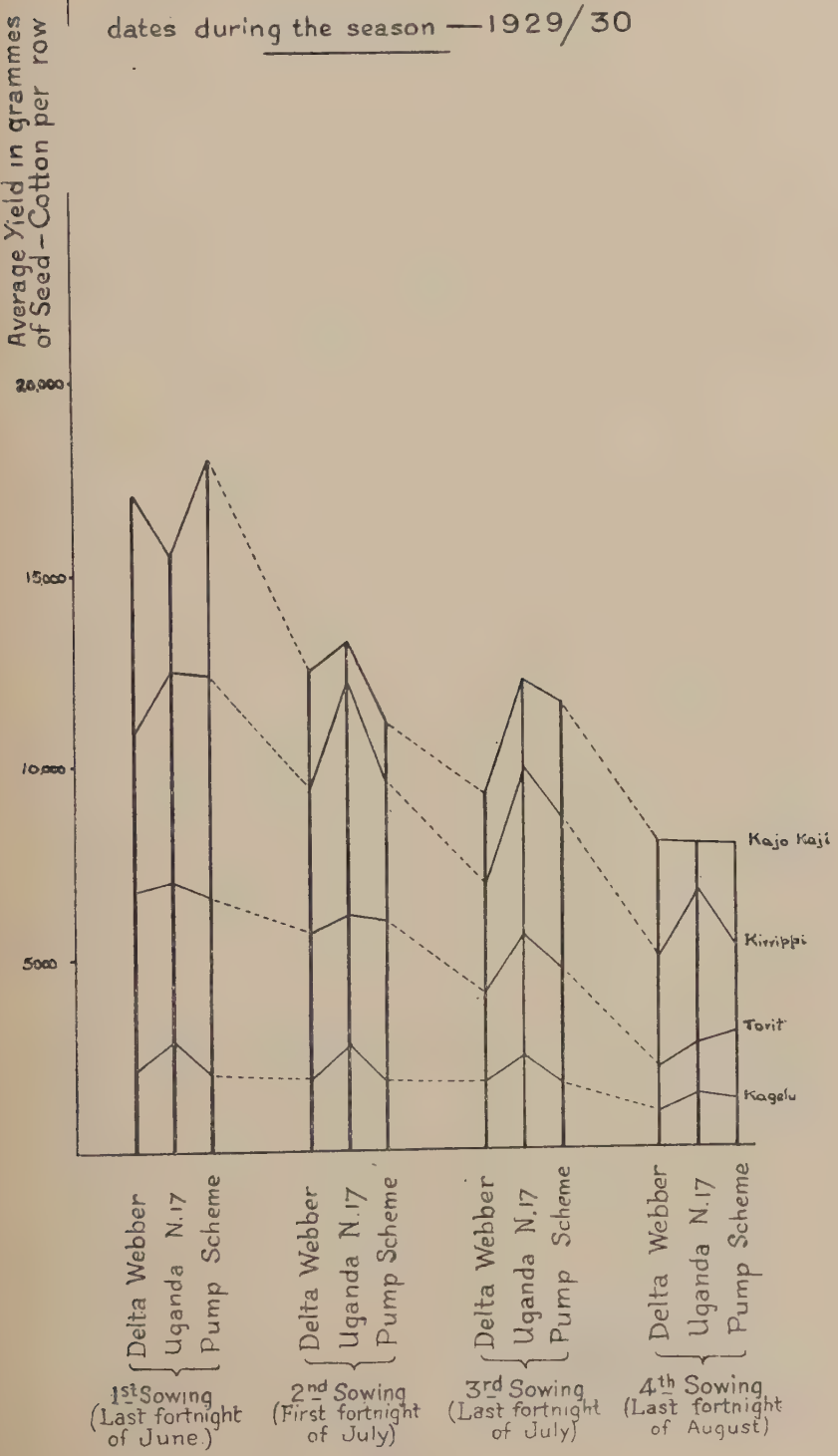


Fig. 9.

Observations were made at all stations on the type of growth shown by the different varieties and on their relative susceptibility to Blackarm and shedding. Apart from Blackarm, pests and diseases, including Red bug, were not serious on these plots.

Blackarm was rather severe at Kagelu, medium at Torit, rather slight at Kirrippi and very slight at Kajo Kaji.

On the whole the observations made at the different stations agreed very well *relatively*, though the averages for all varieties taken together showed great variation from place to place, *e.g.*, the average height of the plants at Torit was 68 cms. and at Kajo Kaji 117 cms.

The average values obtained for all four stations are shown below :—

Variety.	*Height in cms.*	*Degree shown by marks on a 1–7 Scale.*			
		Vigour.	*Erectness.*	*Amount of Blackarm.*	*Amount of Shedding.*
Delta Webber	92	4·4	3·8	3·4	4·6
Pump Scheme	110	4·7	4·6	4·1	4·8
Uganda	105	4·7	3·9	3·7	4·6

It will be seen that, on the whole, Delta Webber showed the smallest damage from Blackarm, whilst Pump Scheme was the most susceptible and also the most inclined to shed.

The Uganda cotton was very similar indeed in general appearance to the Pump Scheme Strain, but rather stouter-stemmed and more bushy. Flower counts were made from time to time but gave very little information as to boll shedding. Flowering started at Torit about 3 weeks earlier than at any of the other stations, followed in turn by Kirrippi (2 months after sowing), Kajo Kaji, and Kagelu. At the last station bud-shedding must have been extremely severe as the flower-curve had scarcely started to rise after an interval of $3\frac{1}{2}$ months from the date of first sowing.

The maximum flowering rate reached at Kagelu was only slightly below that at Torit, where it just failed to reach a figure of 0.4 flowers per plant per day. Kirrippi first and second sowings reached 0.9, and Kajo Kaji gave the high figure of 1.3 flowers per plant per day for the first sowing, and slightly lower results for the second sowing.

(iii) Preliminary Variety Observation Plots.

Seven varieties were tested at each of the four stations.

The varieties were :—

Columbia 40.
Delta Webber.
Webber 49, Strain 2.

Pedigree Dixie.
Pump Scheme.
Uganda S.G. 15.
Uganda S.G. 26.

Except in a few cases, where the supply of seed was insufficient, each variety occupied an area of half a feddan which was divided equally into two portions, one of which was " dug " as far as local tools allowed and the other left undug. Both portions were kept clear of weeds.

There were no " replicate " subplots in this case, owing to the difficulty of carrying out an experiment on such lines, so the results must be regarded as giving *only the barest indications* as regards yields.

Careful notes were made in January of irregularities in the plots due to soil or other accidental circumstances, and with this and other available information as to germination, stand etc, an attempt has been made to *estimate* relative positions which the varieties would have occupied if the plots had been even and regular.

The cultivation given to the ground before sowing gave improved results in practically every case except at Kirrippi, where in four cases out of seven the uncultivated gave the higher yield. On the average, for all varieties at all localities, the increase in yield brought about as the result of cultivation was 16%.

In the following table the actual yields for all varieties are given, together with a " suggested " order of merit, in which the varieties are placed in the order in which it is thought they would have stood if " accidents " of stand, soil-variation etc, could have been eliminated, the highest yielder being marked " 1. " in each case.

Varieties.	Torit.		Kirrippi.		Kajo Kaji.		Meridi.	
	Yield obtained (Rottles per feddan.)	*Suggested Order of Yield.*	*Yield obtained (Rottles per feddan.)*	*Suggested Order of Yield.*	*Yield obtained (Rottles per feddan.)*	*Suggested Order of Yield.*	*Yield obtained (Rottles per feddan.)*	*Suggested Order of Yield.*
Delta Webber ...	736	2	714	1	460	2	832	5
Webber 49 Strain 2	534	5	608	7	248	5	514	7
Columbia 40 ...	556	4	836	3	308	5	820	3
Pedigree Dixie ...	618	3	776	5	276	4	924	1
Pump Scheme Strain	548	6	712	3	256	5	844	3
Uganda S.G. 15 ...	666	1	798	5	324	3	780	5
Uganda S.G. 26 ...	466	7	876	2	472	1	840	2

The suggested final order of merit, when compared with the actual figures, shows, if nothing else, the impossibility of taking figures from

single plots as they stand. The extreme case is that of Delta Webber at Kirrippi, where a very considerable number of trees had been stripped clean by elephants. These caused a certain amount of loss also in the subplots of Pump Scheme, Webber 49, and Pedigree Dixie, but did not penetrate further into the experimental area. Irregularities of soil and stand, though less spectacular, caused variations in individual plots which were probably almost equal in degree in certain cases.

As far as it is possible to draw conclusions from these results it would appear that Delta Webber has put up the most generally satisfactory performance as regards yield, followed closely by Uganda S.G.26. The consistently bad results given by "Webber 49, Strain 2" make it clear that this variety is not suitable for this area, thus confirming the deductions made from the Standard Variety Test Series in which it was also included.

Various records were made in the field as to the type of growth and relative susceptibility to disease of these varieties. Blackarm was present in all cases, being worst at Torit and relatively slight at Kajo Kaji. The severity of attack was recorded, in this as in other cases, by a system of marks, 7 being a very severe infection. The result is shown below :—

Variety.	*Torit.*	*Kirrippi.*	*Kajo Kaji.*	*Meridi.*	*Average.*
Delta Webber	5	1	2	5	3·2
Webber 49 (2)	7	2	2	6	4·2
Columbia 40	6	4	3	5	4·5
Pedigree Dixie	5	3	2	4	3·5
Pump Scheme	6	5	4	5	5·0
Uganda S.G. 15	5	4	5	6	5·0
Uganda S.G. 26	4	4	4	4	4·0

It will be seen that Delta Webber was one of the least susceptible and that Webber 49 was extremely variable, thus confirming results obtained in the standard tests. Pump Scheme and the closely related Uganda S.G. 15 appeared to be the most susceptible in these southern plots, though the former and, to a less extent, the latter had been found to escape relatively lightly in the less rainy Nuba Mountains district.

Ginning out-turn figures supplied by Mr. Bretherton, are available for Torit. The figures agree fairly closely with expectation based on experience previously obtained with these varieties in other districts, Pump Scheme and Delta Webber giving the highest returns and the two Uganda varieties the lowest.

The actual figures were as follows :—

Pump Scheme Strain	30.2.
Delta Webber	... 29.9.
Pedigree Dixie	... 29.7.
Webber 49, Strain 2.	28.6.
Columbia 40	... 28.0.
Uganda S.G. 26	... 27.9.
Uganda S.G. 15	... 27.4.

It is of interest to note that the sub-plots which had received some preliminary cultivation gave in almost all cases a slightly higher ginning out-turn, the increase, on the average, amounting to just under one per cent.

On the whole these experiments with rain-grown cotton in the Southern Provinces have given results of considerable value, considering the small scale on which they were carried out. The Plant Breeding Section is co-operating with the Agricultural Staff again in the coming season in a similar but more extended series of experiments.

(Included by courtesy of the Uganda Government.)

UGANDA

REPORT OF THE COTTON BREEDING SECTION DEPARTMENT OF AGRICULTURE SEASON 1929-30

BY

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SUMMARY.

The experimental crop at Serere yielded much below the average owing to adverse weather conditions coupled with the ravages of Blackarm.

Remarkably low soil temperatures were recorded during the season especially in the critical months of July and August.

The rainfall was abnormal, June was very dry while October and December were excessively wet.

Blackarm was undoubtedly a very serious agent in reducing the crop at Serere, the main attack appearing in October. Several semi-resistant types were observed and selected in the breeding plot.

The outstanding feature of the season, from the breeding point of view, was the success of the strain U.4 which was imported for the first time from South Africa (pages 274 and 276).

In the breeding plot itself S.G.85, a selection from Kagwara in Teso, gave even better results than U.4. Re-selections from both these strains have been made in an attempt to improve the quality of the lint which at present is rather short and harsh (page 274).

The strain S.G.23·8 was grown in a two-acre medium bulk increase plot and again exhibited a low rate of boll shedding (page 277).

Trials with S.G.27 a good quality cotton were very disappointing, the yield being low in each test.

The results of the Variety Trials at Serere, Bukalasa and other outside centres are given on pages 280 to 286. In all cases Fisher's Analysis of Variance was used in working out the results.

Sowing date and Spacing experiments were conducted at Serere, Ngetta, Kamuge and Kaberomaido. The results of these, given on pages 287 to 291, confirm the results of previous years in showing the value of early planting as against late July and August sowing, and, except in the case of Kamuge, the value of closer spacing, *i.e.*, 3 feet by 1 foot as against normal 4 feet by 1 foot.

The Continuous Planting experiment was continued and showed up well the beneficial effects of applications of kraal manure to semi-exhausted soil (page 291).

A uniformity trial was carried out on one of the new blocks and the results will be of great value in laying out experiments on this plot (page 293).

The Mulondo Seed Farm area was used for the first time. The area was planted with S.G.29 seed and the scheme worked quite satisfactorily, except for a small acreage planted.

Samples from the Senior Agricultural Officer's $\frac{1}{4}$-acre trial plots were examined in the laboratory. No significant differences in yield were obtained, but S.G.29 showed superiority in general quality.

Insect pests were less serious than usual. Jassids appeared early in the season, but disappeared after the abnormal rains.

The quality of lint from the general crop was below normal, chiefly on account of a high percentage of immature cotton being picked.

The lint index and seed weight in Teso and Lango were reduced by from 20% to 40%, this reduction having a considerable effect on the total yield.

General.

Bukalasa and Serere.—Work commenced early in 1930 on the new Cotton Laboratory which is being erected at Bukalasa, the building being finally handed over in September. With the establishment of two centres for cotton breeding it will be possible now to cover the whole of Buganda Province as well as the Eastern Province. The area which each centre will serve is divided roughly so that Bukalasa will serve the "Long Grass" districts which include Buganda and Bunyoro while Serere will serve the "Short Grass" districts comprising the Eastern and the rest of the Northern Provinces.

It is intended to establish permanent centres for Variety Trials in each area—the centres for the Serere Area have been selected for the forthcoming season and it is hoped that it will be possible to make a start with centres in Buganda in time for the 1931-32 season.

The land required for Cotton breeding work at Bukalasa and Serere has now been definitely allocated and on each plot a three year rotation will be carried on to avoid exhaustion of the soil.

Summary of Meteorological Conditions.

The total rainfall for the season was well above normal, the latter end of the year experiencing very high rainfall coupled with low soil temperatures. July again gave less sunshine than the other months and the soil temperatures reached a minimum.

Cotton sown in May and early June experienced a dry spell of twenty days in June which checked the plants considerably. This was followed by lack of sunshine and low soil temperatures in July. July cotton was planted in a normally wettish month with very low soil temperatures; these were possibly too low for acute Blackarm attack. August planted cotton received normal sunshine and rain during its growing period.

The abnormally low soil temperatures from September to the end of the year probably affected the earlier sown cotton more than July and August sowings owing to the former having been so severely checked by drought in the early stages.

Month.	*Rain.*	*Sunshine.*	*Soil Temperatures.*
May ...	Slightly above normal ...	Normal ...	Rather low.
June ...	Well below average, the last 20 days receiving only 0·29 inches.	Normal ...	Above average.
July ...	Little above normal ...	Very cloudy, very little sun.	Abnormally low.
August ...	Below average	Normal	Normal to cool.
September	Above normal	Very sunny ...	Low, much below average.
October ...	Record rainfall for this month. Heavy showers.	Normal	Much below average.
November	Below average	Sunny	Still low.
December	Record rainfall for the month.	Below average	Still below normal.

TABLE I.

Summary of Meteorological Observations at Serere.

	Rainfall.			*Sunshine.*	*Soil Temperatures.*	
1929.	*Total monthly inches.*	*No. of days of rain.*	*Deviation from 1921-29 mean.*	*Daily mean, Hours.*	*One foot, daily Means.*	*Deviation from mean of 1927 and 1928.*
March ...	2·23	9	—1·51	8·2	84·9	+0·1
April ...	10·48	21	+1·56	6·7	80·8	+0·2
May ...	6·37	18	+0·34	7·6	77·6	—0·5
June ...	3·24	9	—1·35	7·6	79·5	+1·5
July ...	5·83	18	+0·81	4·9	75·4	—2·0
August ...	4·48	14	—1·70	7·5	77·9	+0·2
September	6·60	16	+0·90	8·4	78·1	—3·0
October ...	9·36	19	+3·86	7·3	78·3	—2·9
November ...	4·35	8	—0·31	7·9	79·8	—0·7
December ...	4·74	13	+3·39	6·4	79·6	—3·7
1930.						
January ...	0·56	6	—0·08	6·6	81·6	—1·4
February ...	3·57	5	+1·63	7·4	82·3	—3·9
Mean ...	61·81	156	+7·54	7·2	79·7	—1·3

Breeding Plot.

A new site for the breeding plot was selected at the top of the three new ten-acre blocks. The plot was divided into three one-acre plots to allow for a three year rotation. Unfortunately Plot A, which was used this year, was unsatisfactory as three rows were badly affected by the avenue of Cedraella on one side of the plot. It has been decided to scrap this plot and to extend further in the other direction.

Part of the plot was dressed with kraal manure with very marked visible effect.

All the progeny rows were sown on July 10th at a spacing of 5 feet by 2 feet. The first fifteen plants in each row were marked off for selfing. Seventy-nine rows were planted consisting mainly of new selections.

FIG. II.
SERERE 1929-30
MONTHLY RAINFALL SOIL TEMPERATURES & SUNSHINE

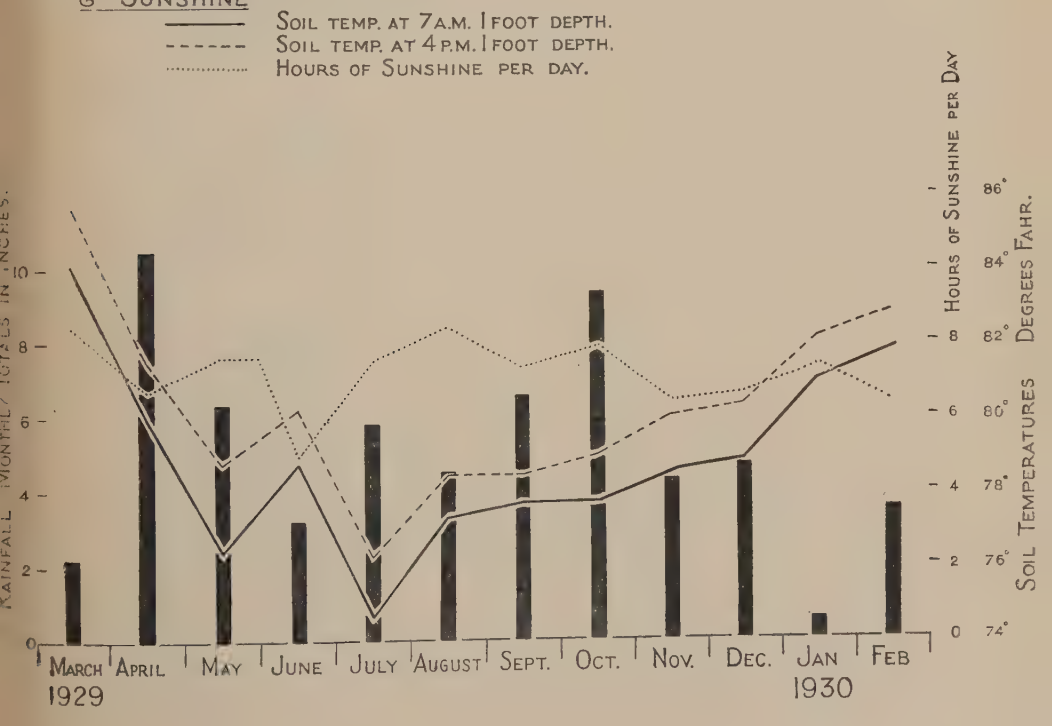
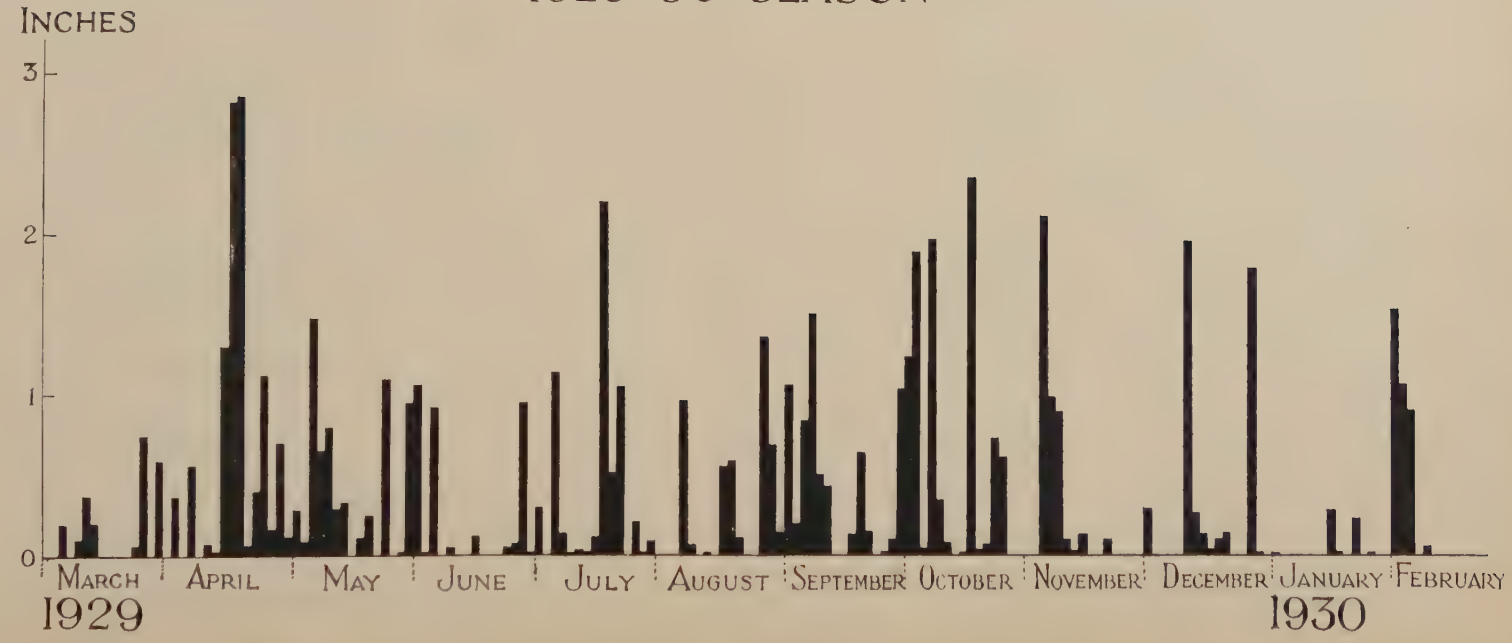


FIG. I.

SERERE RAINFALL

(IN 2 DAY TOTALS)

1929-30 SEASON



The general results were very disappointing, less than half the crop of the previous year being harvested although the rows were planted on the same day as last year. The chief causes of failure were adverse weather conditions coupled with a severe attack of Blackarm.

The original germination was very poor and two re-sowings were necessary in August. Subsequent growth was very slow and flowering was a fortnight later than last season. Blackarm appeared late in October and rapidly ran through the plot. Careful observations with regard to resistance to this disease were made, and considerable variation was observed in this connection. The two highest resisting strains were S.G.85 and U.4 which are discussed later. The heavy rains in December enabled the plants to recover from attack, but this was too late to have any effect on the crop. The amount of immature bolls and lint was very high, this being in part due to Blackarm and also to excessive rainfall. Picking commenced on November 28th and was continued as usual at five day intervals. So few sound bolls were obtained that it was impossible to get any results from the boll analysis except in the case of U.4 and S.G.85.

Owing to the poor habit of the usual Nyasaland type in this country it has been decided to pay special attention to the development of a more erect type with less straggly monopodia, as a fairly high proportion of the crop must be lost every season by bolls lying on the ground. The most promising types with regard to this character were an Acala selection and also a re-selection from S.G.15, but unfortunately these were unsatisfactory in other respects.

The re-selections from S.G.7 (Salisbury) were very badly attacked by Blackarm and only one strain was retained, this being an off type showing a certain amount of resistance to the disease.

The S.G.29 re-selections were very poor yielders and only one, S.G.29.9.9, was worth retaining on account of its comparative uniformity.

Three strains from S.G.35 (a green fuzzed type) showed resistance to Blackarm in that they retained their leaves, but their rates of boll shedding were very high. Several selections were made from these.

Re-selections from S.G.23.8 were disappointing as they all gave very high rates of boll shedding, but these results are misleading as the three families are those referred to above which suffered from tree effect.

The most outstanding types were S.G.85 and U.4—S.G.85 was a single plant selection made in the previous season in a native plot at Kagwara. It was very vigorous and had a fairly erect habit. The row showed obvious signs of splitting into two types—the normal

Nyasaland type and the S.G.85 type. This latter showed considerable resistance to Blackarm and gave very high yields, one plant giving over 10 ozs. of seed cotton. The lint characters are not too good, the staple being on the short side and the lint rather inclined to be harsh. Several selections were made in the row with the object of improving these characters. The following table gives a summary of the quantitative characters of the selected plants :—

TABLE II.

Plant No.	*Total bolls picked.*	*No. of seeds per boll.*	*Motes per boll.*	*Lint wt. per boll.* gms.	*Lint. length,* mms.	*Lint. index*	*Ginning outturn.*
1	71	33·2	1·8	1·56	31·6	4·7	32·7
7	79	—	—	—	29·2	4·2	34·1
11	100	—	—	—	31·5	—	—
16	42	30·8	1·8	1·41	28·6	4·6	32·9
18	49	—	—	—	32·0	—	—
20	93	30·5	1·7	1·65	32·4	5·4	33·2
24	105	29·5	2·3	1·45	30·1	4·9	35·9
29	75	32·4	1·4	1·32	29·7	4·1	34·4
34	199	30·8	1·0	1·06	26·5	3·4	31·0

The strain U.4 is a selection made by Mr. Parnell in South Africa from a strain of cotton which originally came from Uganda. In practically every country in which it has been tried it has fully lived up to its reputation in being a heavy cropper on poor soils, in jassid resistance and in resistance to drought. In this, its first trial in Uganda, it exhibited all these characteristics together with resistance to Blackarm. A progeny row and also a small bulk increase plot were planted with this strain and the results are fully discussed under the heading Increase Plots. Several plants were selected in the progeny row with the object of improving the staple and quality of lint which at present is short and harsh.

Reference Plot.

Two row plots of a number of varieties for reference purposes were planted at the same time as the breeding plot.

Allen.—Although this was not selfed previous to 1924 this strain has kept comparatively true to type. The plants were fairly erect and a moderately good yield was obtained from them.

Sunflower.—This type is now very mixed and probably very little of the original material remains. The plants were very straggly and yielded badly. The little lint that was produced was of very good quality.

Arizona.—This variety yielded fairly well, but its lint was very short and harsh.

Meade.—Some extraordinarily good plants appeared in the plot. Two selections were made, each of which yielded well and had very good lint.

Kasch, Mebane, Acala, Bancroft, Sea Island — All these types were complete failures; Blackarm killed most of the plants and hardly a sound boll was produced amongst them.

MULTIPLICATION.

(*a*) *Small Bulk Increase Plots.*—*S.G.*96 (*S.G.*27.15.13.5). This is the produce of a single plant (No. 5) in progeny row S.G.27.15.13 of the previous season. Sufficient seed was obtained from this plant to sow 1/9th acre, which was done in July. Unfortunately the plot chosen was subject to a great amount of wash with the result that many plants were completely torn out of the ground and in addition the soil was poor and shallow so that the resulting yield at the rate of 109 lbs. per acre is not unduly low. This strain having been selfed and selected for four generations is approaching fixity of type and will be very useful as a standard for reaction to weather conditions from year to year. Most plants were badly attacked by Blackarm. The following characters were recorded :—

Lint Length. mms.	*Seeds per boll.*	*Motes per boll.*	*Lint Index.*	*Wt. of 100 seeds.*	*G.O.T.*
29·28 ± 0·16 s.d. 1·65	30·3	2·7	3·93	8·51	31·5

The lint is fairly strong, silky and regular.

*S.G.*27.15.13.—This strain is the parent family of S.G.96. It yielded very well in the breeding plot of the previous season and its lint characters were very desirable. One $\frac{1}{4}$-acre plot was sown in early July and an additional $\frac{1}{4}$ acre in August. The latter plot yielded very badly, again demonstrating the inadvisability of late planting at Serere. The yields were as follows :—

July sown ... 348 lbs. per acre.
August ,, ... 54 ,, ,, ,,

Blackarm attacked the plants severely in October but they recovered in January.

The following characters were recorded :—

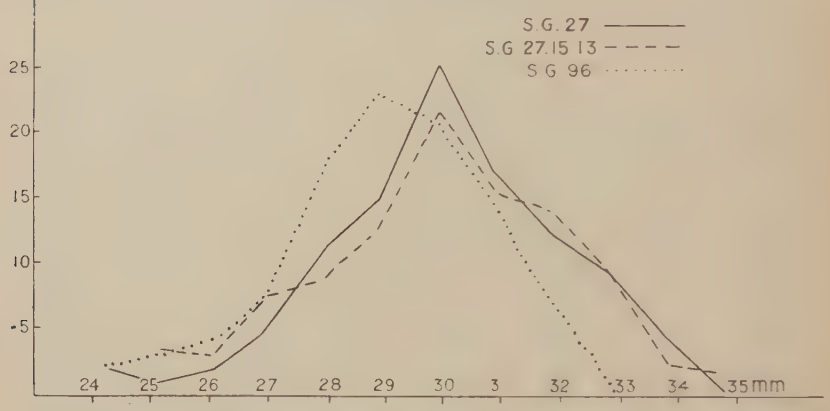
Lint Length. mms.	*Seeds per boll.*	*Motes per boll.*	*Lint Index.*	*Seed Weight.*	*G.O.T.*	*Bolls per plant.*
30.07 ± 0·17 s. d. 2·12	30·5	2·7	3·91	8·84	30·9	14·7

It will be noted that its characters are very similar to those of S.G.96.

Figure 3 shows the lint length curves of the parent strain S.G.27 and of these two sub-strains.

FIG. III

LINT LENGTH CURVES.



*U.*4.—In addition to the row of this strain in the Breeding Plot discussed above, sufficient seed was available to sow a ¼-acre increase plot in July. Germination was very rapid and subsequent growth was vigorous. The plants exhibited considerable variation in habit, but as a whole they were considerably more erect than the normal local plants. Flowering and bolling were very prolific and the plot yielded at the rate of 1,014 lbs. per acre. Considerable resistance to Blackarm was observed, but there was much variation in this character.

The lint was rather below our present standard being very harsh and rather short. Numerous selections have been made with the hope of improving these characters.

One hundred plants were used for observation purposes and from these the following figures were obtained :—

Flowers per plant.	*Bolls per plant.*	*Percentage bolls shed.*	*No. seeds per boll.*	*No. Motes per boll.*	*Wt. of 100 seeds.*	*Lint Index.*	*Lint length. mms.*
75·6	28·1	62·7	31·9	1·45	8·05	4·36	28·59 ± 0·26 s.d. 2·06

This strain was included in the variety trial at Serere where it gave a significantly higher yield than any other strain.

*S.G.*29.— An isolated ¼-acre plot was planted with this strain to keep up a nucleus supply of the original seed. It gave a yield equivalent to 360 lbs. per acre.

(*b*) *Medium Bulk Increase Plot.*—It was originally intended to run the strain B.1 up in bulk and a two-acre plot was actually sown, but the spinning test reports received in August were so emphatic as to its poor spinning qualities that it was decided to replace it with *S.G.*23.8 which had been well reported on by the spinners and which was the lowest boll shedder so far available. Accordingly seed of this strain was planted in between the rows of B.1 and the latter were uprooted as soon as 23.8 germinated. The crop made slow progress and was attacked by Blackarm in November, but despite this and the late sowing, a yield of 239 lbs. per acre was obtained. Observation rows were used for flower and boll counts, etc., and the figures from these gave a boll shedding percentage of only 54·4% a very low figure for this season and indicating that low shedding is a definite character of the strain. Unfortunately this low shedding rate is coupled with a low flowering rate and selections are being made to try and improve this without impairing the low shedding character.

This strain was tested out in the variety trials at Serere, Ngetta, Achwa, Labori, Katawi and Toroma, and the results are summarised below :—

TABLE III.

		Heavy Soils.		*Medium-Light Soils.*			
		Serere.	*Labori.*	*Ngetta.*	*Achwa.*	*Katakwi.*	*Toroma.*
Yields in lbs. per acre.	N.17	284	333	143	42	56	124
	S.G.23·8	299	400	73	41	66	92
S.G.23·8	Lint length in mms.	29·4	30·1	28·8	—	29·1	28·7
	Lint Index	3·2	3·1	2·8	—	3·6	3·7
	Ginning Outturn	32·7	33·2	30·0	—	35·6	35·2

It appears that S.G.23.8 yields better than N.17 on heavy types of soil while on the lighter soils the position is reversed.

The seed is very small and light and the lint index is very low. The general quality of the lint is fair, the staple being rather on the short side.

(*c*) *Bulk Increase Plot.—S.G.*27.—This is a medium yielding strain with lint of very good quality. The main crop on the Serere experimental farm was planted with it with the intention of providing sufficient seed to plant up the Mulondo Seed Farm area in the next season. Owing, however, to most of the crop being planted in August a very

low yield resulted and insufficient seed was produced for Mulondo. At the same time the variety trials showed S.G.27 to be a definitely low yielder and further multiplication would be inadvisable. Re-selections from this strain are in various stages and it is to be hoped that one will be found which will yield well and at the same time retain the good lint qualities of the original parent. The results from the Serere main crop were as follows :—

Block.	*Acreage.*	*Spacing.*	*Seed rate.*	*Yield in lbs. per acre.*	*Date sown.*
3	8	4′ × 2′	3½ lbs.	130·2	22–26 August.
5	9	„	„	117·0	17–20 „
8	10	4′ × 1½′	„	383·0	28–29 July.

The strain was included in all the variety trials and the results are summarised below :—

	Serere.	*Labori.*	*Katakwi.*	*Toroma.*	*Ngetta.*
Yield (lbs. per acre) ...	254	276	56	84	127
Lint Length in mms. ...	30·4	31·1	30·1	28·5	29·8
Lint Index	3·48	3·32	3·67	3·46	2·73
Ginning Outturn ...	31·3	30·9	34·2	33·3	26·1

In all cases N.17 yielded considerably higher than S.G.27.

The Mulondo "Seed Farm" Area.

As outlined in last season's report, the Mulondo peninsula was selected for the seed farm unit for the Eastern Province, being the first step in Mr. Clay's scheme for seed distribution.

Every assistance was received from the Administration to ensure success in the first year of working—a road was made from Labori to the Meruka headquarters where a permanent store was erected for storing seed and seed cotton. The District Commissioner also took pains in explaining to the native growers what was expected from them.

Two belts of candelabra euphorbia were planted 1,000 yards apart to provide a safety belt within which no cotton could be planted ; this also formed a boundary which no native was allowed to cross with seed cotton either to or from Mulondo.

As soon as the scheme was approved three natives trained at Serere were stationed in the area to ensure proper uprooting and burning of the old crop, to root up any volunteer plants, to distribute and supervise the planting of the seed, to make a complete register of growers

so that a check could be made during the buying period, to encourage proper sorting of the cotton and to assist in the buying of the crop. They carried out this work very satisfactorily and are being retained for the same work in the coming season.

The area was planted with S.G.29 strain, the seed being obtained from the main crops at Serere and Simsa of the previous season. In addition to the seed for Mulondo which was issued at the rate of 10 lbs. per plot, 5,000 lbs. of the same strain were distributed to growers on the borders of the Meruka in order to form an extra margin of safety in the event of some natives slipping over the boundaries with cotton to sell at the store. Planting was later than normal owing to an early dry spell and this was no doubt partly responsible for the comparatively low yield obtained, as June appears to be the best sowing month for this area. The area planted was 280 acres. The crop made good progress but was attacked by Blackarm, though not to the same extent as the crop elsewhere. There was a three weeks drought in August which gave a considerable check to the later planted crop and this no doubt affected the yield considerably. Very few stainers were observed until the end of the season when they were too late to do any appreciable harm.

Buying commenced on January 27th, at the same time as the general crop. Messrs. Foster Brothers did the buying personally as arrangements had been made for them to buy, gin and sell the cotton in Liverpool and to obtain special reports from brokers and spinners handling the crop. Samples of seed cotton were taken at various intervals for laboratory examination and the results are summarised in the Table below :—

TABLE IV.

Summary of Cotton Samples from Mulondo.

Date taken.	*Lint length. mms.*	*s.d.*	*Lint Index.*	*Seed Weight.*	*G.O.T.*
January 27th	31·27	2·25	4·75	9·08	32·1
February 3rd	31·16	2·23	4·29	8·80	32·6
,, 10th	31·15	2·87	4·15	8·78	32·1
,, 27th	31·06	1·89	4·04	7·94	33·7
March 7th	30·44	2·09	4·07	8·37	32·7

It is interesting to note the steady drop in staple, lint index and seed weight as buying proceeded. The general quality of the crop was good and considerably better than the general crop in Teso.

The total crop sold was 70,617 lbs. of 1st quality seed cotton and 6,775 lbs. of low grade cotton, giving a grand total of 77,393 lbs., this

being equivalent to a yield of 276 lbs. per acre. This is a very satisfactory yield considering the season, but is much below the average for this area.

The crop was ginned by Messrs. Foster Bros. at their Kasilo ginnery where no other cotton was ginned this season. The ginnery was thoroughly cleaned out and there was but little chance of mixing with odd seeds from last year. The crop ginned out very well giving a ginning percentage of 31·16%. A total of 54 bales of 1st quality were produced and have been sent to Liverpool under special marks for brokers' and spinners' reports.

Considering this is the first season of working this area, the results are quite satisfactory except for the very disappointing acreage. Special efforts will be made next season to increase the acreage considerably.

Next season the area will again be planted up with S.G.29. Of this season's crop 45,106 lbs. of S.G.29 seed from Mulondo have been handed over to the Field Division for distribution.

Variety Trials.

(*a*) *Serere.*—It was decided to use a portion of the previous year's Sowing Date and Spacing Trial for the variety trial. After the cotton had been uprooted and burnt from this portion the plots were sown with Bulo (*Eleusine coracana*). A good stand resulted and this was ploughed in at the end of June and cross ploughed four days later. The area was disc harrowed on July 10th. Heavy rains in mid-July allowed the bulo to make new growth and as a result some of the straw had to be carried off as it decomposed too slowly.

Eight varieties were included in the trial—N.17, S.G.7, S.G.26, S.G.27, S.G.29, S.G.23.8, B.1 and U.4.

An 8 × 8 Latin square was adopted as being the most suitable layout. The plots were 36 feet by 33 feet (approximately 1/36th acre). Nine rows of 22 plants were sown per plot at a spacing of 4 feet by 1½ feet, the rows being sown across the direction of the slope which was very marked. Alleys six feet wide were left between the plots and, by keeping these rough, little wash was experienced considering the nature of the slope.

Previous to planting, each hole was marked by a small stick, and at planting the seeds were sown at the base of sticks. As the seeds germinated the sticks were removed and stand counts were made by deducting the number of sticks left from 198—the possible number of holes per plot.

All the plots were sown on July 27th, six seeds being sown per hole. Two re-sowings were made on August 7th and 19th, stand counts being made at the same time. Thinning to one plant per hole was done with scissors when the plants were about five inches high. The following shows the mean percentage stand for all varieties at the time of first re-sowing and at the final count :—

TABLE V.

Variety.	*U.4*	*S.G.23.8*	*N.17*	*S.G.7*	*S.G.26*	*S.G.27*	*S.G.29*	*B.1*
Count at 1st resowing	82·6	75·4	72·0	74·8	69·6	73·2	72·7	61·8
Final stand	97·0	97·5	96·8	98·3	92·4	97·9	98·3	96·6

The mean of the final stand was 96·7%.

The first flowers opened on September 28th when observation rows of ten plants per hole were marked off for daily flower counts.

Picking commenced on December 9th and was continued at weekly intervals until February 24th.

The results were as follows :—

Variety.	*Mean yield seed cotton per plot in lbs.*	*Mean 1st quality seed cotton in lbs.*
U.4	19·8	10·1
S.G.23·8	11·0	7·0
N.17	10·4	6·2
S.G.29	9·8	5·4
S.G.27	9·4	5·2
S.G.7	8·4	4·5
S.G.26	7·9	4·6
B.1	8·0	5·0

S.E. of Mean	1·164 lbs. or 10·98%	0·790 lbs. or 13·2% of mean.
S.E. Comparison	0·582 ,, 5·5 %	0·395 ,, 6·6% ,,

Conclusions :—

Total Seed Cotton.	*1st Quality cotton only.*
U.4 significantly better than all other varieties	
S.G. 23·8 better than all except U.4 and N.17	Better than all except U.4 and N.17
N.17 better than S.G.7, B.1 and S.G.26	Better than all except U.4 and S.G.23·8.
S.G.29 better than S.G.7, B.1 and S.G.26.	
S.G. 27 better than B.1 and S.G.26.	

The picking curves showed that the 6th pick was the peak for U.4, the 7th for N.17, S.G.27 and S.G.29, and the 8th for S.G.23.8.

S.G.23.8 although giving the lowest flowering curve was second in yield thus further confirming its low boll shedding habit.

The three strains B.1, S.G.7 and S.G.26 are being discarded as being wholly unsuitable to Uganda conditions.

Fig. 4, shows clearly the great superiority of U.4 over N.17 at all periods of the picking curve. S.G.23.8 shows up definitely as a late maturing strain.

(*b*) *Other Centres.*—The main work in Teso, apart from Serere, was concentrated on an effort to improve the cotton yield in the counties of Usuku and Nepak. Variety trials were carried out at Katakwi and Toroma and at the former centre a few progeny rows and a mixed plot of all types of cotton were grown. As in previous years these trials were practically a complete failure, except that they again showed clearly that under existing conditions cotton is not an economic crop in such an area. Blackarm was very bad on all the plots and in December most of the plants were merely bare sticks. There appears to be a hard pan 10 to 12 inches below the surface of the soil through which the roots of the cotton plant are unable to penetrate. The root system is thus poorly developed and the plants suffer readily from physiological drought, a condition which is confirmed by the appearance of the plants.

No significant differences were obtained between any of the varieties tried at Katakwi and Toroma. The progeny rows at Katakwi, which included a row of U.4, were a complete failure.

The yields per acre calculated from those trials shows clearly the very poor return obtained in this area :—

Centre.	*Calculated yield of seed cotton per acre. (lbs.)*	*Return per acre in shillings at 12s. per 100 lbs.*
Achwa (Amuria Co.) ...	41·6	5.00
Katakwi	56·0	6.72
Toroma	124·0	14.90

The trial at Achwa although not in Usuku county was on similar soil to the other trials and gave similar negative results.

Labori.—This centre has been chosen as being representative of the heavy lake shore soils which give high yields and good quality cotton.

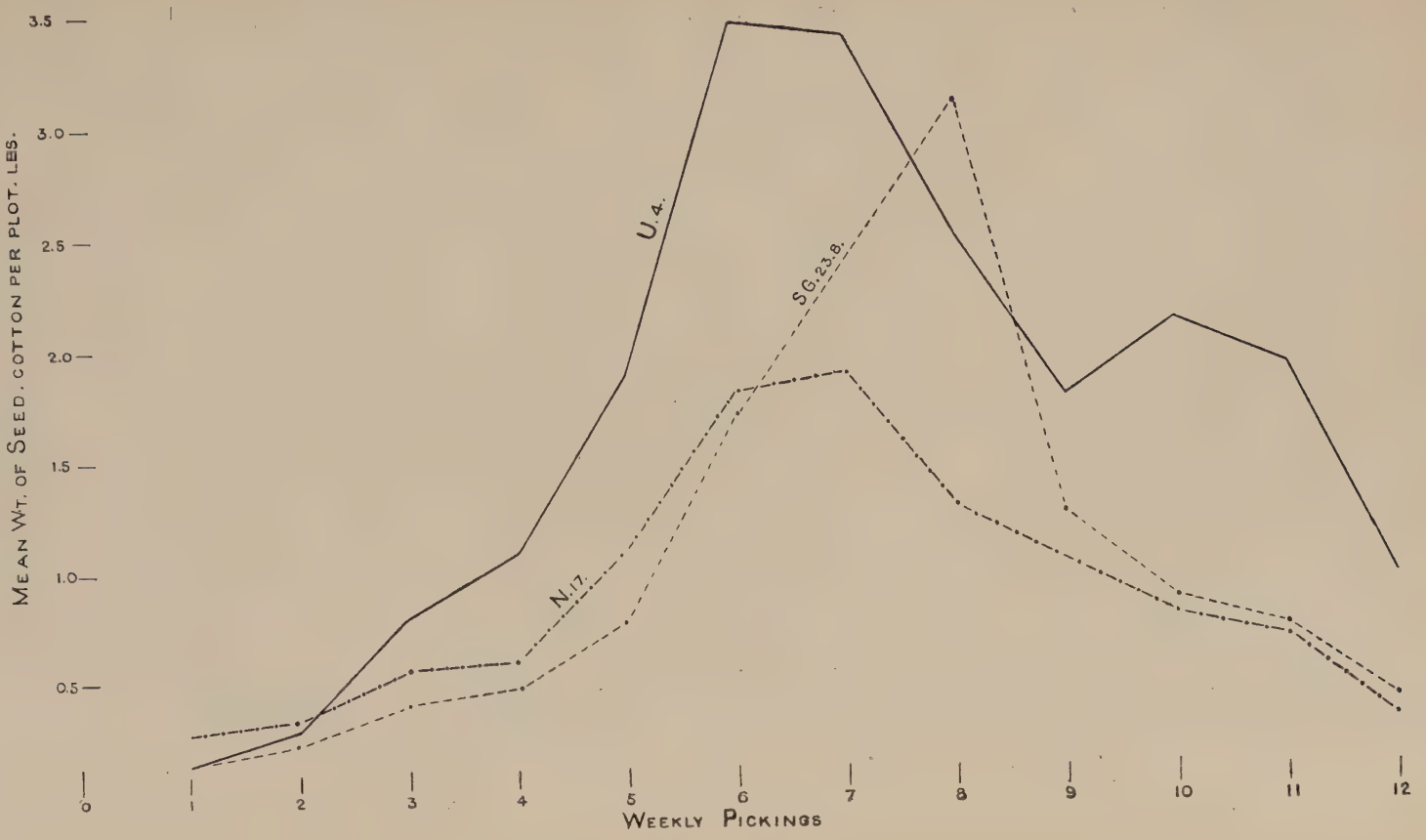
The variety trial consisted of six types—N.17, S.G.27, S.G.29, S.G.23.8, S.G.7 and B.1.

The layout adopted consisted of six random blocks.

FIG. IV.

SERERE VARIETY TRIAL 1929-30.

PICKING CURVES.



The plots were sown on July 30th—late for this area—at a 4 feet by 1½ feet spacing. Germination was very bad owing to lack of rain and resowing was done on September 5th after which a fair stand was obtained.

The general yield of the crop was much below average, but the drop was proportional to that of the rest of Teso. The quality of lint was good, the staple being about 1 mm. longer than at Serere. The results were as follows :—

YIELD OF SEED COTTON PER PLOT IN LBS.

	Variety.						
	N.17	*S.G.7*	*S.G.27*	*S.G.29*	*S.G.23·8*	*B.1*	*S.E. of Comparison.*
Yield per plot (1/52 acre) ...	6·4	5·1	5·3	5·7	7·7	5·2	0.178
Yields expressed as percentage of mean	108·4	86·4	89·8	96·6	130·5	88·1	3·1%

Conclusions :—

S.G.23.8 gave a significant yield over all other varieties.

N.17 was significant over S.G.7, S.G.27, S.G.29 and B.1.

S.G.29 was significant over S.G.27, S.G.7 and B.1.

There was no significance between the others.

Ngetta.—A variety trial was conducted here under the supervision of the Agricultural Officer. Six varieties were grown similar to those at Labori. The layout was in five random blocks. All varieties suffered badly from Blackarm and as a consequence the yields were very low. The results were as follows :—

	Variety.						
	N.17	*S.G.7*	*S.G.27*	*S.G.29*	*S.G.23·8*	*B.1*	*S.E. of comparison.*
Yield per plot in lbs.	5·67	4·18	5·14	7·08	2·94	3·85	0·249
Yields as percentage of mean ...	118	86·5	106	146	61	80	5·2%

Conclusions :—

S.G. 29 is significant over all other varieties.

N.17 ,, ,, ,, S.G.7, S.G.23.8 and B.1.

S.G.27 ,, ,, ,, ,, ,, ,, ,,

All varieties are significant over S.G.23.8.

Kamuge.—The variety trial was under the supervision of the Agricultural Officer, Mbale, and consisted of four varieties in eight random blocks. The results were as follows :—

	Variety.					
	N.17	*S.G.27*	*S.G.29*	*B.1*	*Mean.*	*S.E. of comparison.*
Yield per plot in lbs.	2·6	2·3	2·1	1·8	2·2	0.244
Yields expressed as percentage of the mean	118	104	95·5	81·5	100	11·1%

Conclusions :—

N.17 is significant over S.G.27 and B.1.

S.G.29 is significant over B.1.

Bukalasa.—Six varieties were tested in a trial carried out by the Agricultural Officer in charge. The types were—Local, S.G.29 once grown at Bukalasa, S.G.29 from Serere, S.G.27 from Serere, B.1 from Serere and N.3/5 from Bukalasa. The layout was in the form of five random blocks. The plots yielded very badly owing to abnormal weather conditions and severe attacks of Blackarm. The results were :—

	Variety.						
	Local.	*S.G.29 (Bukalasa)*	*S.G.29 (Serere)*	*S.G.27*	*B.1*	*N.3/5*	*Mean.*
Yields per plot in lbs.	1·24	1·57	1·09	1·32	1·0	2·33	1·43
Yields a percentage of mean	86·5	109·5	76	94	70	164	100

The analysis of variance showed no significance between variance due to varieties and that due to random errors, so that no conclusions can be drawn from the experiment, except that insufficient repetitions were used.

Results of Analysis of Seed Cotton Samples from the Bukalasa Variety Trials :—

Variety.	*Lint Length.*	*s.d.*	*Lint Index.*	*Weight of 100 seeds.*	*Ginning outturn.*
N.3/5	30·36 mms.	2·70	5·18	10·61	32·3
Local	29·54	2·16	4·95	11·36	30·2
S.G.29 (grown at Bukalasa)	31·40	2·00	5·86	11·98	32·8
S.G. 29 (Serere seed)...	31·32	2·24	5·38	11·98	31·0
S.G.27	30·76	1·87	5·37	12·08	30·84
B.1	32·48	2·13	5·29	12·04	30·4

TABLE VI.

Summary of Variety Trials.

Teso District.

Variety.	Serere.			Labori.			Achwa.			Katakwi.			Toroma.		
	Yield per acre. lbs. of seed cotton.	*Lint length. mms.*	*Lint Index.*	*Yield per acre. lbs. of seed cotton.*	*Lint Length. mms.*	*Lint Index.*	*Yield per acre.*	*Lint length. mms.*	*Lint Index.*	*Yield per acre. lbs. of seed cotton.*	*Lint length. mms.*	*Lint Index.*	*Yield per acre. lbs. of seed cotton.*	*Lint length. mms.*	*Lint Index.*
N.17 ...	284	29·5	3·5	333	30·4	3·4	42	29·6	2·8	56	29·6	3·3	124	29·6	3·02
S.G.27 ...	254	30·4	3·5	276	31·1	3·3	30	—	—	56	30·1	3·7	84	28·5	3·5
S.G.29 ...	265	30·8	3·8	283	31·2	3·5	39	31·1	2·8	62	29·9	3·2	62	29·8	3·8
S.G.23·8	299	29·4	3·2	400	30·1	3·1	41	—	—	66	29·1	3·6	92	28·7	3·7
S.G.7 ...	229	—	—	265	—	—	40	—	—	66	—	—	94	—	—
U.4 ...	536	28·9	4·4	—	—	—	—	—	—	—	—	—	—	—	—
B.1 ...	217	31·2	3·5	270	—	—	—	—	—	36	—	—	—	—	—

Sowing Date and Spacing Experiments.

(*a*) *Serere.*—The area chosen for this experiment was under cotton experiments in the previous season. Bulo was sown over the whole area in March and was dug in by hand on May 2nd. It was then disc-harrowed and finally cultivated with an ordinary harrow on May 11th.

It was decided to try three spacings at each of six sowing dates, making eighteen treatments in all. The spacings were 4 feet by 1½ feet (normal), 3 feet by 2 feet, and 3 feet by 1 foot, and the sowing dates May 17th, June 1st, June 16th, July 1st, July 16th and July 31st. As it is probable that this experiment will be carried on over a number of years it was decided to adhere rigidly to the planting dates irrespective of the weather conditions on those days. The sowing dates were separated by only fourteen days as it was decided to omit any re-sowings, and to ensure a good stand ten seeds per hole were sown. The holes were thinned to one plant per hole by scissors.

The layout adopted was in the form of ten random blocks, each of the eighteen treatments occurring once at random in each block.

Since outside rows had to be broken down at harvest to eliminate competition between adjacent plots of different sowing dates, it was necessary to compensate the plot in such a way that equal areas would be picked from each plot thus :

Spacing.	*No. of rows planted.*	*No. of rows harvested.*	*Plants per row sown.*	*Plants per row harvested.*	*Area harvested per plot.*
4′ × 1½′	9	7	20	17	720 sq. ft.
3′ × 2′	12	10	15	12	720 „ „
3′ × 1′	12	10	29	24	720 „ „

The extra six square feet needed to bring the 4 feet by 1½ feet plots up to 720 sq. feet was obtained by not breaking down one of the outside row plants in each plot.

The rows were planted across the direction of the slope and each pair of plots was surrounded by a small ditch.

A considerable number of blanks were caused by rats digging up the seed before it germinated and also by young plants being washed away by heavy showers.

Owing to excessively dry conditions in June, the June 16th and July 1st sowing dates germinated at the same time and consequently there was no difference between their yields.

The summary of the results is given in the Table below :—

TABLE VII.

MEAN YIELDS PER PLOT IN LBS. OF SEED COTTON.

Sowing Date.	*Spacings.*			*Sowing Date Means.*
	4′ × 1½′	3′ × 2′	3′ × 1′	
May 17th	3·52	3·34	3·50	3·45
June 1st	3·52	3·36	3·59	3·49
June 16th	4·06	4·11	4·87	4·35
July 1st	4·33	4·33	5·28	4·64
July 16th	3·52	3·83	4·42	3·92
July 31st	1·91	2·06	2·69	2·22
Spacing Means	3·48	3·51	4·06	3·68

The following results were obtained :—

From the analysis of variance the standard error of comparison was 0·356 lbs. or 9·7 % of the mean, and the standard error of the whole experiment was 0.796 lbs. or 21·6 % of the mean.

The variance due to Sowing Dates was highly significant over random errors while the variance due to Spacings and interaction of sowing date and spacing were not significant.

Conclusions :—

A. Sowing Dates :

All sowings are significant over July 31st planting.

No significance between May 17th and June 1st and none between June 16th and July 1st.

June 16th is significant over May 17th, June 1st and July 31st.

July 1st is significant over all sowings except June 16th.

B. Spacings :

There is no significance between the three spacings irrespective of sowing date.

3 feet by 1 foot is significant over the others in the June 16th and July 1st sowings, and is significant over 4 feet by 1½ feet in the July 16th and July 31st sowings.

This is the first time out of five consecutive Sowing Date trials that the earliest sowings have not shown a marked superiority over the others, but at the same time this experiment confirms the others in showing that planting after the middle of July is accompanied by a considerable reduction in yield.

Fig. 5 below shows the nature of the interaction between the dates of sowing and spacings. It can be seen that the superiority of 3 feet by 1 foot spacing over the others is emphasised in the later sowings.

FIG. V.

INTERACTION BETWEEN SPACING & SOWING DATE

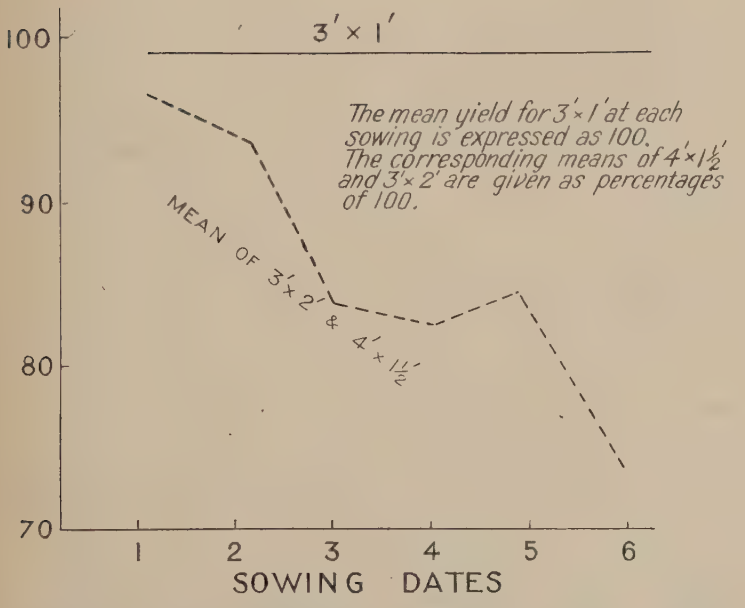
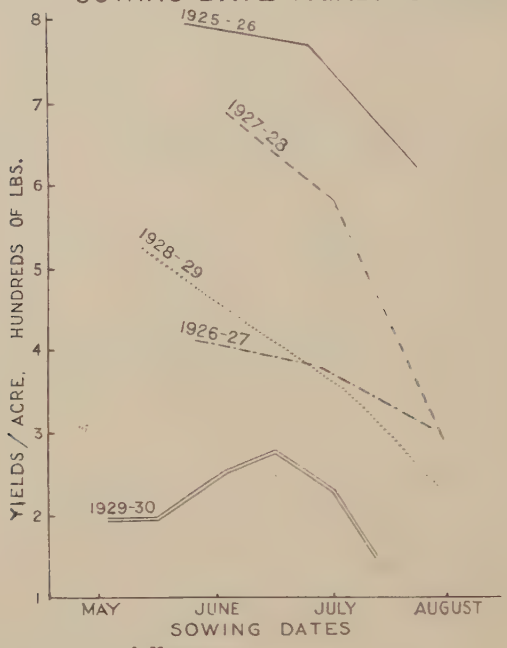


Fig. 6 (p. 290) presents a summary of the results obtained in the Sowing Date and Spacing Experiment since it was laid down in 1925 at Serere. The drop in yield after mid-July plantings is very marked in every case, and these results, combined with general experience, indicate that the optimum time of planting at Serere is between mid-June and mid-July, while August planting should be avoided except in an emergency.

(*b*) *Other Centres.*—Sowing date and spacing experiments were carried out under the supervision of the Agricultural Officers concerned at Bukalasa, Ngetta, Kamuge and Kaberomaido. No results were obtained at Bukalasa owing to the failure of the crop.

Kamuge (*Bugwere District*).—In this trial two spacings, 4 feet by 1½ feet and 3 feet by 1 foot were tried at each of four sowing dates. The layout adopted was in the form of random blocks, five blocks being used.

FIG VI
SOWING DATE TRIALS - SERERE



The results were as follows :—

YIELDS OF SEED COTTON IN LBS. PER PLOT.

Spacing.	*Sowing Date.*				*Mean.*
	May.	*June.*	*July.*	*August.*	
4′ × 1½′	7·25	2·70	1·39	1·50	3·20
3′ × 1′	5·90	3·45	1·80	0·85	3·00
Mean	6·57	3·08	1·58	1·18	3·10

The Standard Error of Comparison was 0.33 lbs. or 10·6 % of the mean.

The analysis of variance showed high significance for interaction of sowing date and spacing and also for sowing date.

Conclusions :

May sowing was significant over all other dates at each spacing.

June sowing was significant over July and August at all spacings.

Normal spacing is significant over closer spacing at May planting.

Ngetta (*Lango District*).—A similar trial to the above was conducted with the omission of August sowing. The layout being in the form of six random blocks.

The results were as follows :—

YIELDS OF SEED COTTON IN LBS. PER PLOT.

Spacing.	*Sowing date.*			*Mean.*
	May.	*June.*	*July.*	
4′ × 1½′ ...	10·55	3·35	2·35	5·41
3′ × 1½′	13·72	4·83	5·20	7·91
Mean ...	12·13	4·09	3·77	6·66

The Standard Error of Comparison was 0·78 lbs. or 11·6 % of the mean.

Conclusions :—

May sowing is significant over June and July irrespective of the spacing.

3 feet by 1 foot spacing is significant over normal at all sowing dates.

The interaction between spacing and sowing date is not significant.

CONTINUOUS PLANTING EXPERIMENT.

The ten plots of this experiment have been under cotton for five seasons out of six, this season making the fourth successive year under cotton. The ten plots were divided into two series—five received an application of 1,800 lbs. of kraal manure each and the others were unmanured. All the plots were sown on July 5th with S.G.27 seed.

The individual plot yields were as follows :—

	Unmanured.		*Manured.*
1/20th Acre plots.	9·41 lbs.	...	20·91 lbs.
	14·21	...	18·27
	12·08	...	16·24
	15·20	...	22·30
	15.04	...	24·66
Mean	13·19		20·48

The difference between these two means is very significant, P being less than 1 %.

In the previous season the means were :—

Unmanured—17·3. Manured—20·6. These were also very significant.

It is noteworthy that the manured plots showed a decrease of 0·12 lbs. only per plot as compared with last season while the unmanured gave a decrease of 4·11 lbs. per plot.

The difference in appearance of the plants in the two series was very marked, the manured plots showing more vigour and ability to recover from Blackarm while the unmanured plants were killed out and were merely dried sticks at the end of the season.

Bud and Boll Shedding Investigation.

This was continued at Serere on more detailed lines and another similar one was carried out at Kampala by the Assistant Entomologist to whom the writers are indebted for the results.

For the purposes of collection of shed buds and bolls two rows of twenty plants were selected and on either side of each row a strip of fine wire gauze was laid on the ground, the two pieces overlapping and a small hole being left for the stem of the plants. Buds and bolls shed were collected by hand from the wire every morning and afternoon and these were classified in the laboratory into various sizes according to the width across the bracts in the case of the buds and to the diameter of the actual boll in the case of bolls. Daily flower counts were also made. The results from Serere and Kampala were plotted in curves and then correlated with weather conditions. It was at once obvious that the main cause of bud shedding was rain, the rain peaks and the peaks of highest shedding coinciding in every case. Evidence was also present that a certain amount of bud shedding was due to wind, especially at Serere in November. The boll shedding, while being correlated to a certain extent with rainfall, was in the main due to some other external influences such as insects or disease. From the tables below it is seen that the greatest loss in potential crop occurs through bud shedding.

TABLE VIII.

Bolls and Buds Shed per Plant (Totals).

		5 *mm.*	8 *mm.*	12 *mm.*	16 *mm.*	24 *mm.*	*over* 24 *mm.*	*Total.*
Buds.	Serere	25·8	6·6	5·0	3·9	4·0	1·0	45·3
	Kampala	57·0	15·6	8·1	6·8	4·9	1·9	96·3
Bolls.	Serere		15·1	2·5	0·7	—	—	18·5
	Kampala		5·7	3·5	1·1	0·5	0·1	10·9

By far the greatest proportion of the buds shed were 5 mm. or under, a result similar to that obtained by Bailey in Egypt and the Sudan.

The following table gives a summary of the results :—

TABLE IX.

Centre.	*Total buds shed.*	*Total flowers produced.*	*Total bolls shed.*	*Potential crop, Bolls.*	*Actual crop, Bolls.*	*Percentage of potential crop produced.*	*Potential Crop Shed. Percentage.*		
							Buds.	*Bolls.*	*Total.*
Serere	45·3	26·3	18·5	71·6	7·8	10·8	63·3	25·9	89·2
Kampala	96·3	24·4	10·9	120·7	13·5	11·0	79·6	9·1	89·0

It is interesting to note that although the proportion of buds and bolls shed differed considerably in the two centres yet the total percentage of crop shed was the same in each case.

Uniformity Trial.

Early in 1929 it was decided to centralise all plot experiments, consequently three new adjacent ten-acre blocks were opened up. This seemed a good opportunity to carry out a "uniformity" trial with cotton on the first of these three new blocks—Block A—during the 1929-30 season. It was hoped that a preliminary trial of this description would give some information as to the most economical size of plot and type of layout for the piece of land in question.

About eight acres of Block A were sown with cotton at 3 feet by 3 feet spacing during the last week of July. As the time for picking approached the whole block was divided into square plots of 1/40th of an acre each—that is eleven rows of eleven plants in each plot. The corners of each of these unit plots were marked with white posts. At picking, ropes were tied to these posts to demarcate the individual plots. Three hundred of the unit plots were picked in all ; they were arranged in twelve rows of twenty-five columns each.

Owing to the available labour being employed with the normal cotton experiments, it was found that the trial could only be picked once. Consequently the plots were left until the end of January, 1930, when harvesting was commenced. After 120 plots had been picked, the station experienced an unexpected week of heavy rain at the beginning of February—3·51″ fell in five days, the mean for the month of February being 1·94″. The remaining 180 plots were picked during the third week of the month. As a result of this rain it was found that the experiment would have to be treated as two separate trials, since the mean plot yield for those plots harvested after rain showed a loss of over 20 % as compared with those picked before rain.

The results have not been fully worked out as yet owing to the large

amount of calculation involved. In calculating the results the following plot sizes have been employed :—

1. Square 1/40ths.
2. Long 1.20ths running parallel to the rows.
3. Long 1/20ths running parallel to the columns.
4. Square 1/10ths.
5. Long 1/10ths running parallel to the rows.
6. Long 1/10ths „ „ „ columns.
7. Long 1/5ths „ „ „ rows.
8. Long 1/5ths „ „ „ columns.

The results obtained so far show that the smallest size of plot is the most economical, as the slight increase in precision gained by the use of much larger plots is not in proportion to the increased land and labour required.

The " Latin Square " is the safest type of lay-out ; this is to be expected, but properly arranged Random Blocks give just as good results in many cases with rather more repetitions. Long plots are not as good as square ones on the whole on the particular block in question.

The sites of old ant-hills do not cause a very marked difference in fertility, but the effect of wash off ant-hills which have not been properly levelled is very marked. The patches where gravel is close to the surface also show a decided drop in fertility.

The experiment has been of value in showing that small plots, and therefore less land and labour, are efficient for accurate plot experiments with cotton on this particular piece of land. Further, the experiment has shown which is the most sensitive type of lay-out for the cotton variety trial in the coming season.

Notes on the Buganda Crop.

A tour of the chief cotton areas in Mengo and Entebbe Districts was made by Mr. Nye in order to become acquainted with cotton-growing conditions in that area prior to his transfer to Bukalasa.

The general condition of the crop was much better than in the Eastern Province. Blackarm was present, but it did not appear to be responsible for much loss of crop except in the dry area in north Bulemezi. Excessive rains in December and January had resulted in a great amount of bud and boll shedding and a comparatively small crop was being harvested except near Nakifuma where a very fine crop had been produced. In most places visited the earlier sown cotton appeared to be giving a much better yield than the late sown crop.

Samples of seed cotton were taken in typical areas for laboratory examination and the results are summarised in the table below.

The general quality of the crop appeared good but there was a considerable quantity of immature cotton present. The lint index and seed weight were normal. The staple was good but rather irregular and indicates a considerable mixing of strains of cotton.

TABLE X.

Summary of Samples Examined from Buganda (grouped into counties).

County.	*Lint Length. (mm.)*	*Wt. of 100 seeds.*	*Lint Index.*	*Ginning Outturn.*
Kyagwe	30·29 s.d. 2·47	11·01	5·47	33·2
Bulemezi	29·98 s.d. 2·51	10·66	5·20	33·0
Mawokota... ...	30·75 s. d. 2·34	10·87	5·15	32·2
Katambula ...	27·94 s.d. 2·14	10·71	5·03	31·9
Gomba	29·18 s.d. 2·12	10·55	5·22	32·9
Busuju	30·30 s.d. 1·81	10·79	5·00	31·6

Notes on the Eastern Province Crop.

Samples received for examination consisted mainly of those from the quarter-acre trial plots which are discussed elsewhere in this report. The general quality of the crop was fair; the lint was rather weak owing to an unusual amount of immature cotton; the staple was rather shorter than usual, especially in Lango. The most remarkable feature of the crop as a whole (S.W. Busoga excepted) apart from the very low yield was the great reduction in seed weight and lint index, amounting to a drop of up to 40 % as compared with normal years. The cause was probably a combination of bad weather and Blackarm giving rise to interference with the food supply of the seed at a critical period. The reduction in lint index can be subdivided into lower individual hair weight and fewer hairs per seed. Several samples were examined and the results were as follows :—

Sample.	*Lint Index.*	*Wt. of 100 hairs.*	*No. of hairs per seed.*
A.	2·3	0.000195 grams.	11,800
B.	4·6	0·000345 ,,	13,300
C.	5·71	0·000414 ,,	13,800

The effect of reduction in seed size is being made the subject of a special investigation. A germination test on different sized seed from the same sample gave the following results :—

Seed size.	*Wt. of 100 seeds.*	*Germination percentage.*
Normal	10·19	73·0
Small	5·68	61·0

Quarter-Acre Trial Plots of S.G.29 and N.17.

A series of $\frac{1}{4}$-acre trial plots of N.17 and S.G.29 were laid down by the Senior Agricultural Officer throughout the Eastern Province to furnish a rough estimate of the comparative merits of these two strains, and at the same time to provide a picture of the variations in yield and quality within the Province.

Fifty centres were selected as being as representative as possible of the main soil and climatic conditions in each district. At each centre one quarter-acre plot each of S.G.29 and N.17 was planted. the sowing being done on the same day throughout the Province.

The writers are indebted to the Senior Agricultural Officer and the Agricultural Officers concerned for the results from these plots and for the samples which have been examined in the laboratory. Thanks are also due to the Empire Cotton Growing Corporation, and to the brokers and the spinners concerned for arranging for reports to be made on a number of these samples.

Total yields of seed cotton were obtained and these were treated as if the whole series was a large variety trial laid out in random blocks. The statistical analysis gave no significance, which was rather to be expected as the yields varied enormously within each district, but it seems indicated that S.G.29 is slightly the better yielder on heavy types of soil, while N.17 is slightly better on the lighter sandy soils. On the whole S.G.29 seems to be better in quality than N.17.

The table below gives a summary of the results obtained :—

TABLE XI.

District.	*No. of centres.*	*Yield per acre. lbs.*		*Lint Length. mms.*		*Lint Index.*	
		N.17	*S.G.29*	*N.17*	*S.G.29*	*N.17*	*S.G.29*
Teso	10	183	200	29·6	30·5	3·34	3·56
Busoga	10	591	614	30·4	31·0	4·16	4·44
Lango	8	259	280	28·9	29·4	3·26	3·38
Budama	6	312	323	28·5	29·3	4·30	4·43
Bugishu	3	255	276	27·3	28·6	3·02	3·79
Bugwere	10	222	219	28·3	28·6	3·71	3·82
Means ...	47	302	335	28·8	29·6	3·63	3·90

The Sudan.

Through the courtesy of the Sudan Government and the Empire Cotton Growing Corporation, Mr. Nye was enabled to return from leave through the Sudan where he carried out a programme arranged by Mr. Bailey, Plant Breeder, which included a stay at the plant breeding station at Shambat, where the opportunity was taken to become acquainted with Mr. Bailey's methods; visits were also paid to the Gezira Research Farm at Wad Medani, the Sudan Plantations Syndicate's area in the Gezira, and to the rain-grown cotton area near Gedaref. The opportunity was also taken while passing through Egypt to pay a visit to the Egyptian Cotton Research Laboratories at Giza under Dr. Balls. A great deal of valuable information was obtained during this trip and it has been of great assistance in drawing up the revised scheme of breeding for Bukalasa and Serere. Mr. Nye is glad of the opportunity to express his thanks to the Sudan Government, to the Empire Cotton Growing Corporation, and to Dr. Balls and Mr. Bailey for all the assistance and facilities which were so readily forthcoming during this tour.

During January Mr. Bailey visited this country and spent a few days at Serere when the opportunity was taken to discuss with him several of the most pressing problems.

NYASALAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS, SEASON 1929-30.

BY

H. C. DUCKER.

Introduction.

Staff.—Mr. Lochrie returned from leave in November. After assisting with the planting at Makwapala he proceeded to Port Herald to superintend the laying out of plots and planting up of the latter station. On his return to Zomba he had the misfortune to suffer a serious breakdown in health which led eventually to his transfer to Swaziland in July. Mr. Miller was in charge of the Makwapala station up to the time of his departure on leave in May, when the routine duties of his post were undertaken by Mr. Lochrie during his convalescence.

The routine duties of the Port Herald Station were done by Mr. Lawrence, now District Agricultural Officer, Lower Shire, who was in charge of this station during the whole season.

Charge of the new Station at Domira Bay on the west shore of Lake Nyasa was undertaken by the author who has to thank Mr. T. R. Walkington, of the Chitala Estate, Domira Bay, for his most kind assistance with this station. In addition, the author was also in charge of the Makwapala Station from the time of Mr. Lochrie's departure on transfer.

Summary.

It is pleasing to be able to report a most successful season, in which a new record has been established for cotton production in Nyasaland.

Substantial increases in yield have been reported from nearly all districts, especially from the Lower Shire areas, and the total crop for 1929-30 is expected to exceed last season's total of some 6,000 bales by not less than 50% of that total.

Planting date propaganda, based on the results of experiments at the Port Herald Station, and on Mr. J. Dickie's Estates at Maperera, has it is hoped had a considerable share in promoting the increase on the Lower Shire, while the success of the Over-the-Top strain produced by Makwapala has had much to do with the increase in up-country areas.

The promise shown last year by U.4. has been fully substantiated by the results obtained with the strain this season, and it seems very probable that it will prove as much in advance of Over-the-Top as the latter was of Nyasaland Upland in areas other than the Lower Shire. In the Chikwawa and Lower Shire areas, however, it will be very difficult to decide on the relative merits of U.4. and of Cambodia, and the latter may yet prove more suited to the needs of the cotton growers, especially if attempts to produce a satisfactorily shaped plant succeed. As has been reported previously the tendency of Cambodia is to produce rather an untidy plant affording good cover to pests.

As foreshadowed last season, work at Makwapala has been concentrated on attempts to ameliorate the unsatisfactory soil conditions at this station. Results to date are very promising, and though it is thought unlikely that this station will again be of use as a cotton selection and breeding centre it may prove most valuable as a general station for study of the special problems of laterised soils.

Work at Port Herald was concentrated on the U.4. and Cambodia strains reported on last year, and the unsatisfactory rainfall distribution at this station gave the surviving strains a most severe test.

The opening of the new Domira Bay Station has provided conditions which approximate closely to the mean of the country, and it appears highly probable that at this station cottons can be bred to suit both winter and summer cropping conditions. The soil is a deep alluvium and is free from the laterised pan which afflicts Makwapala.

It possesses also an advantage over Port Herald in that jassid can be expected to attack the crop every season so that the danger of a jassid-susceptible strain providing a deceptive success is thus minimised, and the mistake into which the behaviour of Foster-Whitehall G. at Port Herald led us in 1926-27 is not likely to be repeated. The Domira Bay Station will allow of summer and semi-summer cropping being done and there is the great additional advantage that flood areas exist in its near vicinity which allow of winter cropping on Port Herald lines.

MAKWAPALA EXPERIMENT STATION, REPORT FOR THE SEASON, 1929-30.

Season.—Apart from a slightly higher December rainfall in the former year there is a great similarity between this past season and 1926-27 when the record yield of cotton at Makwapala was made.

The rains broke early, were well distributed, and never excessive in amount and the result has been good returns from every crop grown on the Station.

The rains ceased rather abruptly on April 25th and thereafter the weather was in general dry and warm up to the cotton uprooting in July.

Minimum temperatures commenced to drop below 60°F. on May 8th, two days earlier than in 1929.

General.—As foreshadowed in the report of last year, work at this Station has been concentrated on the special soil problems provided by the laterisation process which has taken place.

Further progress has been made in improving the ridge terraces, which now need very little to be done to them beyond being widened. Dry season operations have been directed towards this end. Soil erosion and its problems appear to have been dealt with satisfactorily by the measures adopted. The main problem now is to improve the soil on the station by means within reach of the general cultivator.

As has been reported previously, implements have been obtained and methods for their usage devised, which promise to do much by the aid of better tillage. The deeper ploughing achieved last season certainly seems to have made an improvement in the general tilth.

The crusting which is typical of laterised soils was definitely less on the land supplied with farm-yard manure last season and every effort is being made to increase supplies of this manure.

Two pole and thatch covered yards for cattle have been erected at small cost, eight new working bullocks purchased, and seventeen head of cattle obtained on loan from the Veterinary Department. Two bullocks died during the year, and the stock on the station now amounts to approximately one beast to two acres in cultivation.

The cropping of the station has been revised to allow of at least a third of the total acreage being planted to deep rooting leguminous crops, and some interesting comparisons have been made between certain of these crops regarding their effect on the tilth.

The method of pot-planting tree seedlings reported last season proved highly successful and excellent results were obtained with the Eucalyptus planted out. The *Callitris* were however a failure due apparently to the seedlings being too small at the time they were set out. The attempt to establish plantings of these is being repeated this season with nurseries sown three months earlier. Arrangements have been made with the Forestry Department whereby an experimental forestry plantation of some six acres is being established along the eastern boundary of the station. This scheme has been assisted greatly by the Blantyre and East Africa Co. Ltd. loaning the land free of charge. The expenses of establishing this plantation are being

borne by the Forestry Department, and the work is being done by Makwapala labour under their supervision.

Valuable information bearing on the soil problems of Makwapala with special reference to the problems of shifting native cultivation on similar soils, is likely to be afforded by this plantation, especially by the section devoted to the regeneration, natural and otherwise, of native trees.

The method of pot-planting seedlings promises also to be of value in obtaining the maximum results from select strains of cotton of which only a few seeds are available, and experiments will be carried out at a future date to compare this method with others which have been tried.

Rotations.—The cropping scheme for the season was as follows :—

	Field.	*Field.*	*Field.*
Rotation I.	Cotton ... 1	Maize ... 10	½ Sunn hemp ½ Jack bean 9
„ II.	Cotton ... 2	Maize ... 11	Groundnuts 8
„ III.	Cotton ... 3	Tobacco ... 12	Pigeon pea 7
„ IV.	Abandoned and used as miscellaneous cropping area.		

In accordance with the revision of the cropping to allow of a greater proportion of pulse crops certain changes were made.

Fields 1, 9, 10 have now been included in a cotton-pulse-cereal rotation, as it has been found necessary to abandon the simple two course cotton-cereal rotations owing to the loss of tilth resulting from it. Field 9, formerly used for general miscellaneous crops, and later for a two course cotton-pulse rotation was sown half to sunnhemp for green manure and half to a deep rooting pulse, the jack bean, (*Canavalia* sp.) for comparison of their relative effects on the soil conditions.

Fields 2, 11, and 8 have now been placed under a cotton-tobacco-maize rotation and the effect of organic manuring under this rotation is the main object of investigations. Farm-yard manure will be used on the maize break.

Fields 3, 11, and 7 have been placed under a cotton-tobacco-pulse rotation for special study of the effects of pigeon pea on the soil.

Fields 4, 5 and 6 are included in a miscellaneous cropping area until such time as any further addition to the rotation range becomes advisable.

The most interesting result observed this season in the rotation cropping was the difference in effect of the two main deep-rooting pulses on the soil. Land which had been under pigeon pea, half the area annual and half biennial, was cleared and ploughed at the same

time as land which had been cropped to jack beans, (*Canavalia*). Both areas were ploughed in mid-September, five months after any effective rainfall had occured, and investigations showed that there was little to choose between the penetrating powers of either crop. The roots of both had reached up to 66 inches below ground level.

The land which had been under pigeon pea, even for one season only, ploughed up far better than that under *Canavalia*, and interesting confirmation of this observation was obtained on the Chimpeni Estate (Mr. G. V. Thorneycroft) some four miles from Makwapala, where the same effect was noted. It would appear that the roots of the pigeon pea, in addition to increasing permeability, have some special effect on the surface soil.

The tobacco plots again did well and further confirmation of the good results of planting tobacco after cotton was thus obtained. The plots sown this year consisted of a range of Western Dark Nyasa strains grown on behalf of the Agricultural Department. From them have been obtained some promising progeny blocks which are to be planted this coming season. This Western tobacco and cotton form the most important money crops of the native and study of their relationships agriculturally is likely to yield valuable results.

The land in Field 9, green manured with sunnhemp, has been prepared for maize this coming season and has a good tilth, but the rotting of the green manure is unsatisfactory in spite of its being ploughed under at an early date. Whether green manuring is a sound practice under Makwapala conditions must remain a matter of doubt for some time yet.

Field Experiments.

The decision was taken this season to concentrate on U.4. as the main variety of cotton grown at Makwapala. Up to now there has been no significance in the time of planting at Makwapala other than sowing with the earliest planting rain for the best results. It was decided, therefore, to confine field experiments this season to the straightforward problem of spacing.

Four extreme spacings were chosen and sown in a six times replicated randomised block layout. Sowing was done on December 21st and satisfactory stands obtained. Thinning to the required spacings was done on January 17th. Continuous records were kept throughout on fruiting, pest infestation, and growth. Apart from partial suppression of plants at the closer spacings, there were no obvious differences in growth and appearance throughout.

Table I gives the results obtained :—

TABLE I.

	Spacing.	*Mean yield per plot (1/40th acre).*	*Plants per acre by counts.*
A	4′ × 3′ single plant ...	19·53 lbs.	3,400
B	4′ × 3′ unthinned ...	22·26 „	9,000
C	4′ × 2′ single plant ...	20·52 „	5,000
D	4′ × 1′ „ „ ...	23·94 „	9,500

ANALYSIS OF RESULTS.

	Degrees of freedom.	*Sum of squares.*	*Variance.*	*S.D.*
Between spacings ...	3	65·3	21·8	—
Within spacings ...	20	248·8	12·4	—
Between blocks	5	57·8	11·6	—
Random	15	191·0	12·75	3·57

S.E. of difference between two means = 2.1 lbs.

From Fisher's table of "t" it will be seen that a difference of 4.5 lbs between the mean yields is probably significant.

As will be seen, the two densest spacings gave a higher total yield. The density of plants per acre is practically the same in the 4′ × 3′ unthinned and the 4′ × 1′ spacing. This was ascertained by counts as well as by calculation. There is a slight superiority, not statistically significant, in favour of the better distribution of the 4′ × 1′.

The wide spaced 4′ × 3′ single plant spacing is not statistically inferior to the 4′ × 1′ spacing.

As far as can be seen there is a progressive increase in yield with the increase in plant density, irrespective of the arrangement.

The two denser spacings gave an earlier and heavier first picking than did the wider spacings, and much of their superiority is due to this.

There was no significant difference between the proportions of stained cotton from each series of plots. The percentage of clean white seed cotton being approximately 88 for each of the series.

Density of plants does not appear to have been the deciding factor in the amount of stainer attack. This affords interesting confirmation of the impression formed from results at Port Herald that, next to environment, variety is the most important factor affecting stainer disease and its incidence.

Cotton Breeding Work.

This was confined to the growing, in progeny blocks, of the single plant selections made from the U.4. sown in Field 9 last season.

The whole series suffered very badly from the poor soil conditions, more especially the crusting of the soil at sowing time, and germination was in consequence unsatisfactory. Field 1 in which they were sown has been used in the cotton-cereal rotation now abandoned.

Each single plant selection was harvested as a small selfed bulk for trial at Domira Bay this coming season.

It has been decided to discontinue cotton breeding work at Makwapala for the present.

Bulk Sowings.—U.4. was sown, the balance of Field 1, Field 2 and Field 3 being planted to this variety. The Field 1 sowing consisted of a selfed bulk from Gatooma, once grown and selfed at Port Herald, and will provide the future bulk stock of U.4. seed at Makwapala.

Fields 2 and 3 were sown with ordinary unselfed bulk U.4. and were used as observation blocks for two methods of cultivation connected with the ridge terraces. In Field 2 the ridges were run downhill towards the terraces so as to permit of better surface drainage than in Field 3, where the cotton ridges were laid up parallel to the terraces on the contour. Growth in Field 2 was more even than that in Field 3, but there proved to be no difference in their final yields.

The whole U.4. bulk on Makwapala provided the very satisfactory return of approximately 197 lbs *lint* per acre, an interesting figure to contrast with the 192 lbs *seed cotton* per acre provided last year by Over-the-Top.

It is pleasing to report that several test-distribution plots in the near neighbourhood of Makwapala gave very similar yields to the station bulk.

Soil Survey.

The most important piece of work done this season at Makwapala has been a complete survey of the soil types, and depths to the laterised pan have been recorded throughout the station. This work took up a great deal of Mr. Miller's time, but will prove a very useful base on which to calculate when we come to assess the improvements that it is found possible to make in the Makwapala soil conditions.

Inspection pits were dug at intervals of fifty yards throughout the cultivation area of the station and a map prepared showing their positions.

Depths to the first signs of laterite were taken in every pit, or to a maximum of two feet if laterite nodules were not found at a shallower depth.

The collated figures for the twelve fields are of interest :—

Field.	*Average depth to Level of Laterite. Inches.*
1	20·83
2	18·75
3	18·08
4	In excess of 2 feet.
5	16·75
6	17·54
7	18·83
8	17·10
9	19·08
10	19·60
11	15·90
12	20·80

Only one field has a soil depth to the laterite pan in excess of 24 inches and only three fields exceed 20 inches in soil depth. It can hardly be wondered at that cotton behaves as a shallow rooted crop and suffers severely from drought as soon as the rains cease. It is an interesting reflection that the one field with soil deeper than two feet is the only part of the Makwapala area which had been cleared by Natives in the past.

Representative root systems of the various crops on the station were dissected out from the soil surrounding them by the aid of a powerful water jet. Of them the cotton, pigeon pea, jack bean (*Canavalia*) and sunnhemp roots were of most interest.

In only one case did the tap root of a cotton plant penetrate more than 16 inches unhindered ; in that one case an ultimate depth of 32 inches was reached. In one instance the tap root split at the laterite layer and one branch of the root system reached 32 inches. In no other case examined did a tap root penetrate more than 16 inches.

The maximum depth reached by sunnhemp, a supposedly deep rooting legume, was 30 inches.

Its behaviour was much on a par with that of the cotton.

It was found however that neither *Canavalia* nor pigeon pea roots found any apparent difficulty in coping with the pan. In both crops it was found that the main root system had been able to penetrate and reach below the pan, even where the induration was such as to need the help of a pick and crowbar to excavate the root system.

It is in these two crops that our chief hope lies of ameliorating the bad soil conditions of Makwapala by the agency of plant roots, and,

as has been said above, they will play an important part in the rotation practice of the farm.

Insect Pests.

Bollworm was present throughout the season but as in 1927 was never able to increase sufficiently in numbers to do any real damage.

The largest source of loss this season was from other causes and of these stainer-borne disease was the most important.

An attempt was made to trap stainers, as they invaded the cotton, on the lines adopted at Gatooma. The first invaders were found in mid-February and a series of seed traps were laid down throughout the entire cotton acreage. Two double handfuls of seed were placed in a shaded depression and formed the trap. Daily examinations of all traps were made from March 1st when all stainers found feeding on the cotton seed were caught and destroyed.

About the first week in April the traps began to be of little use in checking the spread of the stainers in the cotton and hand picking in the field was started. In spite of this, and of the destruction of large numbers of broods, it proved impossible to cope with the invasion and in mid-June stainers were present in numbers and breeding freely.

The total destruction of stainers amounted to something in excess of 50,000 and so far as could be judged from the ultimate number present, was useless.

A more hopeful line than the destruction of the stainer at Makwapala would seem to be some study of the relationship between the disease it carries and the environment. It would appear possible that the conditions which militate against the effectiveness of the stainer as a carrier are more important than the mere presence of the insect.

The low-lying areas to the east and south of Makwapala contain many host plants of the various stainers. While these exist as a source of practically unlimited numbers of stainers there does not appear much hope that any attack direct will deal with the pests.

An indirect means of avoiding the damage done would seem more promising and in this connection it is of interest to report that there is a possibility of U.4. allowing a modification in the planting date used at Makwapala.

Quite by chance a small plot of this strain was sown at Mr. Thorneycroft's Tengerangilu Estate rather late in January, and, instead of proving the failure which previous experience with Over-the-Top and other varieties would have lead us to expect, the plot gave a good yield of remarkably clean lint, in spite of being late and strongly infested with stainers. A Time-of-Planting experiment is accordingly being arranged at Makwapala with U.4. this coming season.

Domira Bay Experiment Station, Report for the Season 1929/30.

General.—Permission to open this station was received from the Corporation early in 1929. Clearing was commenced in good time and 30 acres of land prepared for planting. It was found, however, impossible to stump the land prior to planting and it was decided to confine the cropping for 1929/30 to bulk observation plots of the three most successful cottons so far tried in the up-country areas.

No buildings other than temporary grass huts were erected in 1929. In the 1930 estimates however provision was made for the erection of two farm buildings and a dwelling house, the latter to be paid for by Government, the former by the Corporation.

Owing to the difficulties arising from Mr. Lochrie's illness and transfer it was found impossible to complete the dwelling house in 1930 and building work this dry season has been confined to the erection of the two stores and the house foundations. The balance of the money needed to complete the house has been carried forward to 1931.

The two stores, now nearly completed, comprise in addition to storage space, a capitao's office and tools store and a farm office for use of the European in charge. They are well built in burnt brick.

Mr. Walkington, Manager of the neighbouring Chitala Estate, has kindly offered the guest-house on his estate for our use during the coming rains.

A further 30 acres has been cleared for this coming season and the Station now straddles the new main road from Dowa to Domira Bay. Its site from a propaganda point of view has much to recommend it.

The soil is an alluvial clay loam overlying eluvial soil derived from highly decomposed schists. It is highly permeable to rain water and the levelness of the site chosen should render soil erosion of little moment. Ridge terraces on the lines of Makwapala will, however, be adopted from the point of view of water conservation. It will be possible to make them at the maximum spacing, so that they should offer little difficulty to the arrangement of plots.

A certain amount of stumping has been done on the land cleared in 1929 and the whole area will again be planted to cotton in 1930/31.

It is hoped to arrange a variety, time-of-planting and spacing trial, and to plant observation blocks of a very large range of cottons, particularly of U.4. and Cambodia sub-strains.

The Corporation wish to record their great indebtedness to Mr. T. R. Walkington, who has kindly seen to the entire routine work of

the station since its inception, and to Mr. H. M. Mitchell of the P.W.D. who has supervised the building construction. Without the generous help of these two gentlemen it would have proved very difficult to get the Station in good shape for the coming season.

The area in which the station is situated is supplied with two rivers which only flow in, and just after, the rains. At other times the only water supply is obtained by digging in the sandy river bed.

An early attempt was accordingly made to obtain water from dug wells and it is pleasing to be able to report that the second of two attempts made has proved completely successful. The first well, sunk near the house site, is not however to be abandoned but will be persisted with next season. It is now down some 38 feet, and is floored with decomposed rock. The writer is advised by the Government Geologist, Mr. F. Dixey, that water may reasonably be expected at about 70 feet and that the supply should be adequate. He has also indicated another site not far from the house where an attempt to dig a well might be made.

A chain survey has been made of the cleared area and the station has been laid out in 5 acre blocks. These measuring 220 × 110 yards have been arranged as nearly as possible with their long sides parallel to the contours, and therefore to the main road, which runs along the ridge line in an east and west direction.

The site of this Station at approximately the centre point of the country should, with its attractive agricultural attributes, make it an excellent headquarters for cotton breeding work. It is easy of access to the western plateaux areas of Angoniland, is within 14 miles of a good Lake port, and hence will be easily reached from any part of the Southern Province when the railway extension to Lake Nyasa becomes an accomplished fact. At present it is connected with other areas by a quite good all-weather road, and may be reached from Zomba in a day by motor car.

The soil of the new station while not the best in the Domira Bay area is a very fair average, and is entirely free from the unpleasant pan experienced at Makwapala.

It will be possible to grow summer crops on the station itself and winter crops on flooded areas within easy reach. The Nkhombedza Dimba, a large fertile area some 4 miles from the station on one of the roads to Lake Nyasa, affords cropping conditions exceedingly like those of Port Herald, in spite of the Domira Bay area being some 1500 feet higher in elevation than is Port Herald. The difference in latitude and the proximity to the lake doubtless has much effect in minimising the difference in elevation.

Another feature of Domira Bay is its freedom from the mist-belt conditions which frequently afflict Makwapala and do so much damage to the cotton—they have done so in five years out of seven to date.

It is hoped that future work will show its suitability as a breeding centre for both winter and summer crop cottons, in which event its position at one end of a small isolated cotton-growing area should make it an admirable seed bulking centre. This area is isolated by strips of waterless country immediately to the north of the Lipimbi river and the south of the Chitala river, between which streams the new station is situated.

Rotations :—The Natives of Domira Bay have a very poor collection of food crops compared with those of other parts of the country and especially with those of the Lower Shire. Bulrush millet (*Pennisetum typhoideum*), a very useful cereal, is, for example, practically unknown, and the pigeon pea (*Cajanus indicus*), appears to be absent altogether. Both should do well. There is little doubt that in addition to affording information of direct use to cotton-growing, a set of suitable rotations of cotton and native food crops will be of considerable value. It is intended to start this work in 1931/32 when the station is well established.

Cotton.—The area cleared in 1929 was planted with 10 acres each of U.4., Cambodia, and Over-the-Top (selection B-30-1).

The writer proceeded to Domira Bay on December 10th. Rains favourable to planting fell on December 15th and following days, and the whole area was planted by the 19th. Excellent germination was obtained with both U.4. and Cambodia (Strain G.C.664/1 ex Port Herald) but the stand obtained with the Over-the-Top was not so good.

Counts of the stands obtained gave the following results on January 25th. Sowings had been done by hand in holes with a spacing 3′6″ × 1′6″.

U.4 78·5%, Cambodia 73·3%, Over-the-Top 45·5%.

The poorer stand of the Over-the-Top was due to the stainer damage done at Makwapala in 1928/29. The Cambodia and U.4. seed were from Port Herald where stainer was conspicuous by its absence in that year.

Growth was good throughout for the new ground conditions, and cropping excellent, in spite of a five weeks' drought in February/March.

Picking commenced on May 28th and was finished on August 8th.

The approximate yields were as follows :—

U.4. 546 lbs seed cotton per acre.
Cambodia 560 lbs „ „ „ „
Over-the-Top 441 lbs „ „ „ „

For the new ground conditions these results can be considered very good and compare favourably with a yield of 593 lbs of seed cotton per acre of U.4 obtained on Mr. Walkington's plot, on the Chitala Estate, on five year old land.

Insect Pests.—What might be described as the normal Nyasaland succession of pests appeared on the cottons and is rather well brought out by the pest observations given in Table II. These observations were made by the capitao in charge of the station who had formerly acted as recording boy at Makwapala.

Jassid became evident early in the season and was most obvious on the U.4, the leaves of which were well reddened by April. In spite of this, the strain did not appear to be much affected, and its final yield was good.

Of the bollworms, *Diparopsis* was most abundant throughout the season, but the usual end of the rains wave of *Chloridea* appeared also. The latter at Makwapala has been shown to be a decisive factor in the degree of bollworm damage. Analysis of sheddings showed the falling off of bollworm attack towards the onset of the dry weather and, to a less marked degree, the increase in non-bollworm loss.

Stainers though always present in large numbers, were responsible for exceedingly little damage. The dry spell in February/March was no doubt a factor in this.

TABLE II.

JASSID COUNTS. NYMPHS WEEKLY PER 50 LEAVES.

	Mean per leaf.					
Date.	*U.4 Field 4.*	*U.4. Field 5.*	*B-30-1 Field 3.*	*B-30-1 Field 6.*	*G.C.664/1 Field 1.*	*G.C.664/1 Field 2.*
13/2/30 ...	2·10	0·18	0·06	0·52	0·56	0·56
20/2/30 ...	0·80	0·01	0·18	0·02	0·10	0·48
27/2/30 ...	0·10	0·22	0·01	—	0·40	0·54
6/3/30 ...	0·86	0·32	0·32	0·04	—	0·18
13/3/30 ...	1·24	0·03	0·32	0·04	0·14	—
20/3/30 ...	1·10	0·52	0·36	0·02	0·16	0·28
27/3/30 ...	1·76	0·52	0·36	—	0·46	0·74
3/4/30 ...	0·86	0·06	0·32	0·04	0·40	0·16
10/4/30 ...	0·56	0·38	0·08	—	0·20	0·26

BOLLWORM COUNTS. WEEKLY PER 100 PLANTS.

Date.	*Diparopsis.*	*Earias.*	*Heliothis.*	*Misc. Leaf Eaters.*
22/2/30	7	7	6	37
1/3/30	18	2	—	50
8/3/30	61	—	—	59
15/3/30	111	5	5	2
22/3/30	88	—	15	14
29/3/30	71	—	1	50
5/4/30	47	—	45	2
12/4/30	42	1	34	40

TABLE II—*continued.*

SHEDDINGS FROM SAMPLE ROW IN FIELD 1. WEEKLY ANALYSIS.

Date.	*Buds*		*Flowers and Bolls.*	
	Bollworm.	*Non-Bollworm.*	*Bollworm.*	*Non-Bollworm.*
21/2/30	86	1	10	3
1/3/30	10	5	57	38
8/3/30	4	—	50	46
15/3/30	4	1	74	21
22/3/30	8	1	81	9
29/3/30	20	3	43	34
5/4/30	15	17	50	18
12/4/30	19	—	29	50

It is unfortunate that after the second week in April the capitao was unable to spare time to continue these observations. The dry season work then commenced and his time was fully occupied with the brickmaking, clearing and other matters.

Flood-land Cotton.—A plot of cotton sown on April 12th in a piece of "Dimba" land near the Station proved a failure. Germination was patchy and growth poor. The plot, which consisted of 1/8th acre U.4 and 1/8th acre Cambodia, was apparently sown too late for the season. It was chosen by the capitao, a stranger to the area, and apparently was poor in subsoil water content. Judging from a number of native-grown plots which were kept under observation, considerable local knowledge is necessary in the matter of choosing dimba gardens for cotton.

PORT HERALD STATION, REPORT FOR SEASON 1929/30.

Season.—This has been a drought year at Port Herald, though, fortunately for the native cotton, the rains elsewhere on the Lower Shire were rather better distributed. Tengani's area, some fifteen miles to the north of the Station, for example, received planting rains in February which missed Port Herald entirely.

The late rains were fair and would have been ample for the cotton at the Station, had the subsoil water content been better built up by the main rains. As it was, the lateness of the planting rains and their small amount proved a handicap which the Station cotton was unable to surmount.

General.—It was decided to increase the cotton area of the station to 30 acres. For this purpose the two-course rotation adhered to hitherto was temporarily abandoned, and the whole station put under a cover crop of sunnhemp during the early rains. This sunnhemp it had been intended to plough under in early January in good time

before the cotton was to be sown. The dry spell in January/February however, made it necessary to burn much of the cover crop instead of allowing it to rot or be devoured by termites. The effect of the cover crop cannot therefore be assessed from the point of view of its value as manure.

The whole area was planted to cotton when the rains at last permitted sowing, most of the bulk cotton being planted in the first fortnight of March.

To provide for a future 30 acres of cotton a further 20 acres have been added to the station, making the total cultivation area 50 acres, and in addition 10 acres of flood land on the Ndinde Marsh area just south of Port Herald is being marked off as an experimental plot. This will allow the results obtained on the dry land area of the present station to be checked for Dimba conditions.

Considerable progress has been made with the co-operative seed multiplication scheme refered to in last season's report. Upwards of 500 growers have been registered and arrangements are being made for a trial bulking during this coming season of U.4 supplied by the Station. U.4 has been chosen in preference to Cambodia, in spite of the latter's superiority this season, on account of the wider range of conditions to which it has shown itself to be suitable.

Whether Cambodia may yet prove more suited to use on the Lower Shire remains to be seen.

Field Experiments.

The variety trial last season indicated that two strains — U.4 and Cambodia G.C.664/1—were so markedly superior to all else that the work of the station should be concentrated on them. This season's work has given us no reason to change this opinion.

It was decided to repeat the comparison of these two strains using Nyasaland Upland as standard, and to combine the variety trial in one set of experiments with a time-of-planting trial, and in another with a series of spacing experiments.

Each variety at each spacing and time of planting was sown in 1/40th acre, 5-row plots replicated six times. One set of randomised blocks was used for the time-of-planting experiment, another for the spacing experiment.

The results given below are obtained on the first two pickings only in order to produce some results in time for inclusion in this report. There is no reason to suppose that the final pickings will modify the result to any appreciable degree.

Spacing Experiment.—Sowing was done in holes on March 5th under good conditions, and excellent germination needing but little supplying was obtained. Apart from drought which gave rise in June/July to a certain amount of defoliation, growth was healthy throughout. Regeneration was not marked as in the previous season, and late pickings are not likely to be large. The yield this season at Port Herald Station amounts to about half what is considered now to be a normal crop.

Pickings were taken on September 13th and again on October 6/7th with the results given in Table III.

TABLE III.

Mean Yield per Plot. Spacing and Variety Experiment.

Cambodia	12·5 lbs. seed cotton		
U.4 ...	10·7 „ „ „		
Nyasaland	9·4 „ „ „	Standard error of difference between two means = 1·3 lbs.	
4′ × 2′	unthinned	13·5 lbs. seed cotton	
4′ × 2′	two plants	7·6 „ „ „	
4′ × 1½′	one plant	9·3 „ „ „	Standard error of difference
4′ × 1′	„ „	13·6 „ „ „	between two means = 1·9 lbs.
4′ × ½′	„ „	10·3 „ „ „	

It will be seen that the relative positions of U.4 and Cambodia have been changed and that the latter, as last season, is definitely superior to Nyasaland Upland. U.4, though higher in yield than Upland, is not significantly superior to the latter. On the other hand there is no significant difference between U.4 and Cambodia. Repetition of the experiment would seem advisable, and it is intended to do this with one of the substrains derived from the Cambodia which may show a better plant type than its parent. The straggling habit of G.C.664 is against its adoption at present. A wet year would almost certainly mean its failure from stainer damage.

The results of the spacing experiment would indicate that yield is in large measure proportionate to plant density. The discrepancy shown by the 4′ × ½′ spacing might be explained by the lack of symmetry of this arrangement. It is highly probable that Port Herald might with advantage use a 3′ spacing between rows with a moderate distance between holes. In this connection it may be observed that the natives' favourite spacing of about 3′ × 3′ with 5 to 7 plants per hole may not be far from the optimum.

Time-of-Planting Experiment.—Lack of planting rains in February confined the range of times of planting to March. No extension was made into April on account of previous results recorded, which indicate a definite disadvantage in sowing as late as this on land not subject to flood.

Sowings were made on the 4th, 11th and 18th March, and fair germination obtained; growth was good, and far more even than has been experienced hitherto. Table IV gives the results obtained.

TABLE IV.

MEAN YIELD PER PLOT. TIME-OF-PLANTING AND VARIETY EXPERIMENT.

Cambodia	13·2 lbs. seed cotton	
U.4 ...	12·2 ,, ,, ,,	Standard error of difference
Nyasaland	10·7 ,, ,, ,,	between two means = 0·90 lbs.

March 4th sowing	13·1 lbs. seed cotton	
,, 11th ,,	12·9 ,, ,, ,,	Standard error of difference
,, 18th ,,	10·1 ,, ,, ,,	between two means = 0.90 lbs.

The earliest sowing date is the best and the latest the worst, and the results provide an excellent confirmation of views expressed previously on the subject of sowing dates. So far as dry land cotton is concerned the Lower Shire native should be encouraged to plant not later than mid-March.

The variety trial in this experiment is an excellent confirmation of the results obtained in the spacing experiment and the same remarks apply. Cambodia was undoubtedly superior in drought resistance to U.4. Continuous records were as usual kept on the two sets of experiments.

COTTON BREEDING WORK.

Bulk Sowings.—The station's bulk cotton this year was U.4. In addition to the bulk from the Port Herald crops of 1929, Mr. Peat of Gatooma Cotton Breeding Station, Southern Rhodesia, kindly supplied enough of his ordinary mixed bulk for some 3 acres. This was obtained in order to increase the available selection range of the Port Herald U.4.

A total of 20 acres of bulk U.4. was planted on the station, and a spacing of $4' \times 1\frac{1}{2}'$ leaving four plants per hole adopted as standard. The results of the spacing experiment indicated that this is not far from optimum, but probably suffers from lack of symmetry. A spacing of $3' \times 2\frac{1}{2}'$ might be an improvement.

Picking is still proceeding (October, 1930) and an average crop of some 350 lbs. clean white seed cotton per acre is in prospect. This yield, while not so good as we hoped to obtain from the appearance of the cottons earlier in the season, is probably as much as could be expected from the amount and distribution of the rainfall received.

Three small bulks from selections made by Mr. Lochrie in 1928 were sown in fields 7 and 10. These were made under rather extreme

jassid conditions and are distinctly promising. Table V gives their general characters as compared with the Gatooma mixed bulk grown side by side with them.

TABLE V.

Strain.	*Halo Lint Length.*	*Ginning %.*	*Wt. 100 seeds.*
Gatooma Bulk	27·8 mm.	35·4	10·8 gms.
P.U.4/5–1	29·3 mm.	35·2	9·65 gms.
P.U.4/5–5	27·7 mm.	36·8	10·35 gms.
P.U.4/5–12	29·5 mm.	35·7	10·95 gms.

The lint lengths and seed weights have been maintained in an admirable fashion under the drought conditions experienced.

The three substrains will be bulked this coming season on $2\frac{1}{2}$-acre blocks and compared in a strain test for yielding power.

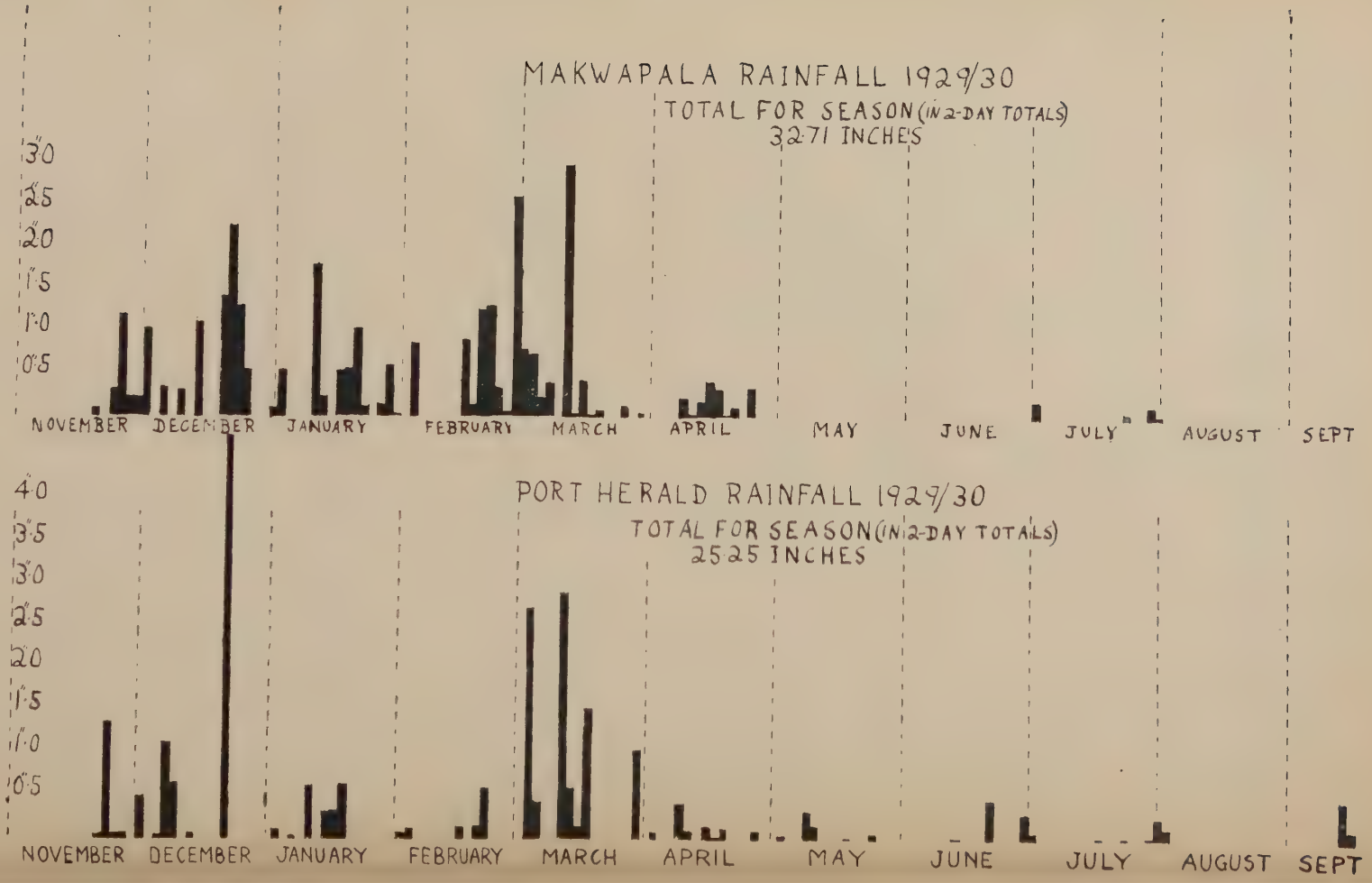
Progeny rows and small bulks.—A large range of progeny rows of U.4 and Cambodia selections were grown in fields 7 and 10, and promise to provide a useful range on which to work. They have been augmented by a number of Cambodia strains kindly supplied by Mr. Peat, which promise to enlarge the selection range of this strain.

Three Punjab-American strains also supplied by Mr. Peat were discarded. All three grew poorly and the lint in all cases was poor, one strain being particularly short.

Harvesting of the various small lots is proceeding at present, and it is hoped to have a generous assortment of the strains in readiness for planting at Domira Bay this coming season. At the new station they will be subjected to jassid as well as drought, both of which Port Herald normally fails to provide.

INSECT PESTS.

There was a marked absence of pests at Port Herald this season. Jassid and stainer have both been negligible. There was no attack of aphis as recorded in the previous year, while bollworm control by the environment has been both early and complete.


MAKWAPALA RAINFALL 1929/30
TOTAL FOR SEASON (IN 2-DAY TOTALS)
32·71 INCHES
3·0
2·5
2·0
1·5
1·0
0·5
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPT
PORT HERALD RAINFALL 1929/30
TOTAL FOR SEASON (IN 2-DAY TOTALS)
25·25 INCHES
4·0
3·5
3·0
2·5
2·0
1·5
1·0
0·5
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPT

NIGERIA

REPORT ON THE CORPORATION'S SEED FARM, DAUDAWA, NORTHERN NIGERIA FOR THE YEAR 1930.

BY
G. BROWNE.

SUMMARY.

Cotton.—In the season 1929–30, 360 acres were planted in cotton on the Main Farm, and yielded 102,241 lbs. of seed cotton, being an average of 284 lbs. per acre. In addition to this, the Co-operative farms, with 31½ acres under cotton, gave an average of 243 lbs. per acre and a total yield of 7,655 lbs. Cotton bought from seed issued to outside neighbouring farmers amounted to 6,204 lbs. The total amount of seed cotton that finally passed through the ginnery was 115,513 lbs., which yielded 34,777 lbs. of lint and 77,673 lbs. of seed. The latter was sent to the Agricultural Department for distribution in their segregated area at Dan Ja. The average ginning percentage for all the cotton passing through the ginnery was 30·11.

The lint was baled at Funtua ginnery, producing 90 bales, which were sold in England. The broker's report was as follows :—" Good Middling to Strict Good Middling, rather high in colour, staple $1\frac{1}{16}$ inch to $1\frac{1}{8}$ inch., wasty. Nominal valued 8·00d. based on July American futures at 7·25d."

Clearing.—Farm Extension No. 2, consisting of 180 acres, was completely cleared, while 20 acres in Extension No. 3, were also cleared, thus making 200 acres cleared in all. The Main Farm is now 680 acres.

Cropping.—This year 500 acres have been planted in cotton, the type being again Strain D supplied from the Agricultural Department's farm at Maigana. This is a selection from native Allen. Seed rate was 14 lbs. per acre. Mucuna beans were planted for green manure to the extent of 160 acres. Twenty acres of cereals were sown and these were augmented by sowing some among beans also.

Co-operative Farms.—Four more farms were added last season, and these have been put in crop ready for completion and occupancy about Christmas. The five farms made last year were duly occupied, the number now being farmed by Co-operators being 12.

Cattle.—Cattle cultivation has been practised on quite a large scale this season as compared with previous years. In all upwards of 800 acres were worked by cattle. The herd now consists of 25 head, 4 of which are young breeding stock.

Recapitulatory.

It may be recalled that last year the farm had reached a total acreage, cleared and cultivated, of 480 acres out of which 360 were planted in cotton. The area has since been increased by some 200 acres, making the total now 680 acres, of which 500 acres were planted in cotton in 1930.

With regard to the Co-operative farms, at the time of writing last year's Report 6 farms were occupied by selected farmers with a further 5 almost ready to be handed over. On these five farms the houses have since been built and both these and another (C.1. on the accompanying chart) have now been taken over by farmers. To the farm C.1. additions have been made to make up for the rocky out-crops.

Clearing.

Clearing commenced in August, an earlier date than has hitherto been adopted on account of there being surplus labour available at the time. The new Extension which almost completely filled the year's clearing programme adjoins the Main Farm on the North-east side and comprises fields 25–33 on the accompanying plan. In addition to this area of 180 acres, a further 20 acres was cleared in Extension 3 to the south of the Sokoto road, thus completing the 200 acres programme. It is naturally a decided advantage to be able to start clearing while the rains are still on, as the soil is then easily dug away from the roots. Work was somewhat delayed by heavy bush in Extension 2 and also by rocky places, some of which (fortunately almost wholly confined to one field) are so considerable as to make the land unsuitable for cotton. It will, however, do very well for cereals. The work was done mostly by contract, a headman and a gang being given an acre per day to clear, cut up and pile. This was not found to be altogether very satisfactory, however, for when dry season cultivation commenced, many roots and stumps were found not dug out; it is thought that improved means of supervision and methods of clearing may prevent this in future. In the long grass it is very difficult to see whether the work has been properly done unless a European is constantly on the spot and this is obviously impossible. A large part of the only field cleared in Extension 3 was farm land

formerly owned by native farmers. This is most difficult land to clear as the trees have been cut off a yard from the ground some years ago, and, the roots being dead, the whole stump has to be dug round and removed bodily. The cost of clearing this is consequently higher than that for normal bush, while, in addition, expropriation fees have been paid on it as " farm land."

Cultivation (Breaking Land).

Dry season cultivation started in March on the newly cleared land. The rains not having then commenced, the work was hard and the progress made was slow. All the land cleared was cultivated. During the past year the land was completely broken and in no case was it found necessary to break and ridge on top. This has seemed in other years rather to affect the ensuing crop, but at the same time the method has its advantages when a large area has to be broken and ridged quickly.

By dint of changing the carburation on one of the Fordson tractors from kerosene to petrol, fairly successful work was obtained from it, when drawing the 3-disc plough, but the amount of oil used and the wear on the big end bearings was so great that it was doubtful if this form of traction should be continued. The question was settled by a connecting rod breaking and puncturing the crankcase, thus putting the tractor finally out of action. The Corporation's Guy lorry, fitted with a half-track caterpillar drive, was then brought into service. This vehicle tackled the work well, at less than half the petrol and oil consumption of the Fordson and very considerably reduced the cost of mechanical cultivation. In a day's work the Guy tractor and plough replaced some 90 labourers, but it should be added that the hand broken land (in the dry season) was perhaps more deeply broken. The disc plough, notwithstanding wheel and other weights, was not sufficiently heavy to penetrate the hard baked soil. Out of the 200 acres broken during the year, more than a quarter (55 acres) were broken by mechanical cultivation in spite of the breakdowns in operating the Fordson. To cultivate this land properly in the dry season, a heavier plough would clearly be necessary in order to secure reasonably deep cultivation. The All Conqueror plough used last season penetrated to a depth of 3 to 4 inches only in most places, though in others it sank to quite a fair depth. This dry season work is of inestimable value when the rains come, not only because it permits the moisture to penetrate earlier but also because it relieves the pressure of work on the farm.

The Sabul plough for use with cattle did not arrive until too late for use last season and it is consequently impossible to report on this method of dry season cultivation also.

Crops.

Cotton.—The seed planted in 1929 was Strain D supplied from the Government Farm at Maigana. The Agricultural Department sent 7,500 lbs., of which 4,700 lbs. were used on the Main Farm. The balance, after planting the Co-operative Farms and supplying, was issued to neighbouring farmers as in previous years, but, although it had not been intended to re-purchase and gin this cotton, this course was ultimately adopted at the request of the Agricultural Department, and the seed was included with that issued to the Department from the Main and Co-operative Farms.

The crop was very late in coming to maturity, picking not commencing until January 6th, which is the latest date since the farm was started. This was due partly at all events to a long drought in the previous June which delayed planting beyond the normal date; possibly also to the present type of cotton taking a little longer to ripen than those previously planted. When picking did start, it was fairly rapid, and was in fact held up somewhat owing to limitations of ginning and store-room capacity. The only incident of note during the growing period was the appearance of jassid in certain fields which caused anxiety at the time, but little or no damage was done and no further development of it occurred. Sudan bollworm was present at one time, but the attack stopped with the cessation of the rains. Picking finished on March 12th. Pickings were fairly heavy over most of the farm, but poor yields from a few fields of the previous year's clearing precluded a high general average. The highest yield for any one field (20 acres) was 433 lbs. The average over the whole farm was 284 lbs. per acre, this figure including the 10 acres planted by Ball's single-seed method, which only average 136 lbs. per acre. The total amount of cotton picked from the Main Farm was 102,241 lbs., of which 2,748 lbs. was No. 2 quality. The ginning outturn over all the season's ginning was 30·11 % of lint and 67·2 % of seed. An actual ginning test with a sample of average quality No. 1 seed cotton gave 31·54 % lint, 67·60 % seed, and 0·85 % waste. The total quantity of lint sent home and sold has been reported to us as 35,951 lbs., while the seed sent to the Agricultural Department amounted to 77,673 lbs. This included 4,300 lbs. of seed obtained from seed cotton purchased from outside farmers and grown from seed issued from Daudawa. The seed

retained as unsuitable for distribution was 1,862 lbs. and was mostly from No. 2 cotton of very poor quality. This seed was used as cattle fodder.

On the whole the 1929–30 crop turned out more successfully than was at one time thought possible. At the end of the season no field gave the impression that it was " poor," and needed a rest and manure ; in fact it is more than likely that if the rotation were increased from two years cotton and one year beans to three years cotton and one year beans, a definite increase in yield might ensue, as the plants in many fields seem to tend to excessive vegetation instead of fruiting. Other fields, however, would admittedly not stand the increased strain of three years cotton, and would need special attention.

Turning to the present crop (1930–31) the first thing to be recorded is the increased acreage under cotton. There are this year 500 acres in cotton on the Main Farm and an area estimated at 45 acres on the Co-operative farms. No seed has been issued to outside farmers this season. The seed issued to us by the Agricultural Department was again Strain D. In all 8,000 lbs. were sent us and planting commenced on June 9th. This is much earlier than usual, but the sowing period was extended over as long a time as possible with the view of determining the optimum time for planting here. From this season's observations it appears that June 9th has turned out to be just a little on the early side, and next year planting will be started a week later should conditions then be favourable. In the earlier-planted cotton germination was good, but towards the end of June, owing to conditions not being very favourable, it began to fall away and in this period heavy " supplies " had to be given. One hundred acres were planted by means of cotton planters, but taken on the whole, they are not as satisfactory as was thought from their preliminary trial last season. They really replace a negligible amount of labour, and while the cost of planting is low (about 9d. per acre) they are slow and conditions may consequently change considerably between the time of starting and finishing a 20-acre field. For small farms, where also labour is difficult to obtain, they will do useful work, but here it is now found best to put a large number of labourers on to a field and finish it in one day while planting conditions remain good. Heavy supplies were necessary following the planters owing to the reasons given above.

Planting continued until July 31st and included a period of almost 3 weeks when none was possible. It is such an eventuality that constitutes the danger of leaving planting until late, when a large

acreage has to be completed. The seed-rate averaged 14 lbs. per acre throughout the Main Farm and the Co-operative Farms, including supplies, which, as mentioned before, were heavy.

With the exception of three fields which have not yet completed the rotation, the new spacing of 3 feet between the rows has been universally adopted. Between the stands the spacing is 18 inches, but as it is difficult to get the natives accustomed to a regular spacing, this varies a little. Some women and children from neighbouring villages were employed, but planting was mostly done by our own labour staff. Women and girls are the best planters, but young children are not employed as they do not understand how important it is to do good work. Thinning to two plants per stand was carried out as usual. Flowering commenced at the end of July, but was not general until towards the end of August. The stand was on the whole the best that has been seen since the farm was started, notwithstanding the increased acreage. This is attributable to improved methods of intercrop cultivation, which are referred to later in the Report. The land cleared and planted during the past year is exceptionally good, and can almost be said to have given a more even stand of cotton than the older land. This is also due however to the better planting conditions which obtained at the later time that it was sown, as well as to better cultivation. Weeding was done almost entirely by cattle, only the weeds between the plants being removed by hand. Later on, cultivation between the rows by means of Ransome's No. 1 Midget cultivator was carried out extensively. In hard and gravelly fields, where cotton had shown up poorly before, this cultivation had an excellent effect, and gave a stand almost as good as that obtained in fields with a much superior soil. About a week or fortnight later the ploughs were run through to ridge up, the whole operation being most successful.

This season, for the first time, the cotton suffered severely from pests. The most serious of these was jassid. When the report was written, there appeared little probability of anything more than a very small crop from 100 acres, including most of the early planted fields. Every field on the farm was more or less damaged, but most of those that were attacked later should nevertheless produce a fair crop. Appreciable damage was also done by the Sudan bollworm, and this would have been more conspicuous had it not been for the far more extensive damage by jassid.

Another noticeable feature has been the large number of stainers present this year: at the time of writing it is too early to assess the probable effect of these pests on the yields. Leaf-curl disease has also been more prevalent than in the last two seasons.

A certain amount of localised damage was done by stem-borer in one field, but this was not extensive. Parts of the same field were also water-logged for a while during the very heavy rains in August, and the cotton suffered rather severely in consequence.

The rainfall during the wet season has not been particularly good from a crop-growing point of view, the incidence being unfavourable. The wet season started well, but a dry period in late June threw things back considerably, while a further, but shorter dry spell towards the end of July had the same effect. In August and September torrential rains fell which caused much damage by erosion. The really useful rains finished early this year and probably the effect of this will be seen about December. The harmattan with its drying winds started early in October, much sooner than usual.

Beans.—Sowing commenced on May 11th which is about the usual time. The seed was again Mucuna, which appears to give excellent results as regards vegetation, and the shoots which come through the ridges after the beans have been turned in make good cattle fodder when cut off, mixed with grass and stacked. Two to three seeds per hole were planted, spacing being about 12 inches. Forty acres out of the 160 planted, were sown with the planters coupled together and drawn by a pair of cattle. (This arrangement, while suitable for planting on the flat is, however, useless for planting on cotton ridges.) Unfortunately, however, beans so planted did not germinate well, and it was found that the planting was too deep. A wider earth plate was fitted to the planter to prevent the coulter entering so deeply into the soil and this made a considerable improvement. On the whole, however, as with cotton, the experience at Dandawa is that hand planting is both superior and cheaper.

The hand-planted beans did very well, but unexpected trouble was met in the shape of the locust invasion mentioned later in this Report. Most of the bean fields had hoppers on them later in the season, and owing to the trampling they received in the course of the locust drives, many fields had to be heavily re-sown. It is interesting to note that the locusts did no direct damage to the beans at all, they even weeded the grass out of several fields and left the beans intact. In the end, good crops bearing heavy foliage were produced, though, for the several reasons mentioned, the crop was exceptionally difficult and expensive to produce. Beans were inter-planted with millet and guinea-corn in one field in which the latter suffered heavily from locust attack. The beans climbed up the stalks of the ruined crops and provided excellent cover on what had seemed as if it would inevitably be a wasted field. The bean fields were all turned in for green manure by the end

of October, with the exception of 13 acres which are being left to provide seed for next year. An attempt was made to turn in the beans with the D.Y. ploughs and 40 acres were actually done in this way, but it was found that they could hardly cover the mass of beans sufficiently. The remainder were accordingly turned in by hand, and the work was better in every way, except in appearance.

Only one field of newly cleared land was planted in beans, and this, as is usual, did not give the amount of foliage which the older land provided.

A consignment of 5 cwt. of Mucuna seed was sent to the sylviculturist at Jos, at the request of the Agricultural Department.

Millet.—The bulrush millet was for the most part a failure owing to the persistent attacks of flying locusts. One field was planted no less than five times and each time it was entirely cleared by locusts. This field is very isolated and did not receive so much attention during the anti-locust campaign as those nearer the village. The stands this year were 6 feet apart (allowing for interplanting later with guinea-corn) and 3 feet ridges. The crop got a good start and in spite of the locust attacks, repeated attempts were made to harvest whatever fields were possible in view of the danger of food shortage throughout the country. In one field 8 acres yielded an average of 747 lbs. per acre and the field-heads gave 481 lbs. per acre. It should be observed that the former received a dressing of F.Y.M. at a critical time and also had more attention in the anti-locust campaign than any of the other land sown in millet.

Guinea-corn.—The remarks made in the foregoing paragraph with regard to the effect of the locust attacks on the millet apply also to the guinea-corn crop. In view of the risk of a food shortage, repeated efforts were made at considerable cost to obtain a crop, but every time it was completely eaten by locusts.

Rice.—A bag of seed rice of an indigenous variety was sent this year from Sokoto at our request. This was planted in the fadamas, and as the supply ran out, a quantity of rice from last season was also sown. In each case, however, it suffered from lack of water. If anything, the indegenous variety is the better of the two.

The rice remaining over from last year, after seed for this year had been taken out, was put up for sale to the labourers, who would not however buy it at any price. They evidently prefer the parboiled and milled rice on sale in the country. It was eventually sold in a few parcels for practically nothing to a few people connected with the farm. This experience has proved that rice is not worth growing here as a foodstuff, even, as this year, at a time when the country appeared

to be in sight of a risk of famine. Obviously, it will be better in future to buy rice from the Agricultural Department's mill at Sokoto and retail it here, thus entailing no outlay in cultivation costs. The demand among the northerners for this Sokoto rice is increasing.

The crop is to be tried, however, for one more year in those fadamas which have not been planted this year, as it may prove a good soil binder to prevent erosion.

Cotton Seed Distribution.

Last season's seed was a good clean sample, rather fuzzier than normal, but very consistent in size and type. Of the 79,535 lbs. produced from the ginnery, only 1,862 lbs. (from the poorer quality seed cotton) were considered unfit for distribution and were used for cattle fodder. The remainder of the seed, *i.e.*, 77,673 lbs., was sent to the Dan Ja area of Southern Katsina as before, where the Agricultural Department has segregated an area from which the seed cotton (grown from Daudawa seed) can be bought and ginned separately, and the seed issued as a commercially pure strain.

Labour.

The period under review has witnessed the greatest change in the labour situation since the Corporation began operations at Daudawa in 1925. The world-wide industrial depression is now making its effects felt in Northern Nigeria. The mines on the Plateau have cut down staff until, for the first time, there are Plateau natives coming west to look for work, instead of natives from Sokoto and still further north, passing eastwards in a constant stream to obtain their seasonal work at the tin mines. Labour is so plentiful that extra men are being given work at a small wage and, in addition, there are large numbers of labourers in the camp awaiting a chance of work. The opportunity has accordingly been taken to weed out inefficient men from the permanent staff. Labour conditions at Daudawa are undoubtedly attractive; water has been conducted to the centre of the camp, good houses are provided (these are too few in the dry season, but this is being remedied), and each man is not only allowed a small plot of land for himself for farming purposes, but also has a chance of getting a Co-operative farm should he prove a good and efficient farmer. Ex-soldiers are constantly drifting along from their Reserve Centres, and are welcomed. A few are unsuitable, but the majority are well disciplined and form a fine body of men, from which almost all headmen are drawn. They also provide the majority of the Co-operative farmers and settle down well. Another reason for the

new popularity of Daudawa as a labour centre is the fact that since the new water supply has been put in, not a single labourer, woman or child who has lived in the camp for 12 months or over, has suffered from Guineaworm, thus fulfilling the hope expressed in the past that the thousands of man-days lost annually through this water-borne disease might be diminished if not completely eliminated by the permanent supply of fresh water to the camp. During the coming dry season a new village is to be started about half a mile along the road nearer Daudawa village, in the spare land occupied by the Corporation between Extension 3 and the Sokoto road. Water may not reach there completely this year, but will be laid as far as possible and the programme finished another year. About a dozen new houses were built on the far side of the road last dry season near to the original camp, but owing to the base-line of the new farm coming very near to the road at this point, little room is available for expansion. A much superior type of workmanship made the new houses look more inviting while it was also possible to reduce the price a little owing to minor assistance being given to the contractor and to the bulk purchase of materials at reduced rates. Labour by contract still continues satisfactorily in most kinds of work, and is much appreciated by the men. At the same time, careful supervision is necessary to ensure that the quality of work does not suffer in the competition to see who can finish work the earliest. To compensate for the increased number of men employed, short time is frequently being worked, a five-days week being popular, with the open day on the local market day. This scheme employs many more men, and when labour conditions become more stringent, it is hoped that a large permanent staff will then be on the spot, already more or less settled. A certain amount of this short time working is the result of the adoption of cattle-cultivation which undoubtedly relieved the formerly somewhat difficult labour situation. The average daily attendance has increased during the last 12 months to 191, where last year, the average was only 125. The death rate, however, has been somewhat heavier, five persons having died in the last year. Some of these were not long resident here. The usual cause of death is tuberculosis or cold of various sorts leading to pneumonia, etc.

Cattle.

Great changes have occurred at Daudawa during the past season in the matter of cattle-cultivation. At the time of writing last year's Report, there were only 3 cattle, whereas there are now 25. Fifteen cattle have been purchased from the Veterinary Camp at Vom, while the rest have been purchased locally. The Vom cattle have the

advantage of being serum producers at the Veterinary Camp and are more or less immune against certain diseases. The Veterinary Department, through the kindness of the C.V.O., Capt. Henderson, have promised to give the locally-purchased cattle injections at an early date against tsetse, the presence of which is still suspected, and great care is taken to run no unnecessary risks in this respect. The herd includes four likely-looking heifers for stock-raising purposes which have been bought locally from passing traders.

The following ploughs were imported from England for use with cattle :—a Ransome's D.Y., a D.Y.H. (larger size of the former), and a Sabul plough for dry season cultivation. The D.Y. and D.Y.H. are both ridging ploughs. The D.Y. proved to be much more satisfactory than its larger counterpart, and another three of these were ordered. The Sabul arrived too late for trial last season. The D.Y. ploughs were used for ridging up land before and after planting, and they kept the fields beautifully clean ; the only hand work to be done was the weeding between the plants. In all, throughout the season, since the ploughs came, 800 acres have been worked. Of course some fields have been worked two or three times and these are included in this figure. It will be seen from this that cattle cultivation is capable of considerable expansion, and is proving its value in saving time, labour and tools. As mentioned in a foregoing paragraph, the ploughs did not do very good work in turning in beans, which was somewhat disappointing, as this would have been a great saving in money, but the work was a little more than these excellent little ploughs could cope with. A Ransome No. 1 Midget Cultivator has also proved a useful implement, being run through weedy or gravelly fields a week or two before the ploughs and giving thoroughly good results.

In addition to this work, cattle are being used for all kinds of other jobs, such as carrying stone and sand for the masons, wood to the pumphouses, and assisting clearing by dragging large pieces of wood to the side in teams of two, four or six oxen. This last is excellent practice for them and teaches them to be quiet in awkward places, and to pull various weights ; it is moreoever most useful in clearing operations.

A new cattle shed is in course of erection, after which a covered rick yard is required. An automatic water trough has been placed in the cattle compound, which is kept filled by a ball valve supplied from the elevated tank. So far, it has only been possible to give a dressing of F.Y.M. to some 10 acres of a nearby field, but this has given excellent results, and by next wet season a large quantity of manure should be ready for spreading.

The cattle have been worked throughout the season on a ration of 5 parts cotton seed to 2 parts kibbled millet or guinea-corn; they have had good grazing besides, of course, and have kept in wonderfully good condition.

Some 350 Fulani cattle were kraaled on the farm after the cotton picking was finished and were grazed on the cotton sticks during the daytime. Night kraaling was done on four fields which it is hoped will benefit thereby. The result of the kraaling in F.5 last year is very evident this season in the increased crops obtained from it. In view of the necessity of feeding our own cattle, certain fields will have to be reserved for them in future.

Mechanical Cultivation.

In spite of the fact that the experiment with tractor cultivation had to be given up last year, a certain amount of further work was done with the better of the two Fordson tractors after some repairs and adjustments had been made. However, trouble was soon experienced in the matter of big-end wear, while oil and petrol consumption were unduly high. Finally, a connecting-rod came adrift and punctured the crankcase, making further work with this machine impossible, for the time being at least.

Some weeks prior to this, the Nigerian Railway Motors handed over to the farm one of the half-track vehicles belonging to the Corporation, with which they had been experimenting. This vehicle was then attached to the plough, and, carried out the work most satisfactorily with approximately half the petrol and oil consumption of the Fordson. In all, out of the 200 acres cleared last dry season, 55 were broken by mechanical means. The work was dry-season cultivation, and while the work done by the disc plough left a good deal to be desired, it penetrated the baked earth to a depth of some four inches and allowed ridges to be made before the rains started. Lack of weight seemed to be the trouble, the wheel weights supplied with the implement having little or no effect. Judging by the excellent stand of cotton obtained on the new land this year, there is no doubt that it is a decided advantage to be able to open up virgin land so that the early rains may penetrate.

The Ginnery.

Seed cotton from the Main Farm, Co-operative farms and from outside farmers to whom the selected seed had been issued, was ginned in the Corporation's ginnery. From the Main Farm the amount of No. 1 quality seed cotton was 99,205 lbs., while the Co-operative farmers sent 7,655 lbs., and the outside farmers 6,204 lbs. of the same quality.

The No. 2 quality from all sources amounted to 2,748 lbs. A ginning test on a sample of 1,525 lbs. taken at random showed 31·54% lint, 67·60% seed and 0·85% waste, while the figures over the whole ginning period are 30·11% lint and 67·20% seed. The lint was sent to Funtua for pressing; and 77,673 lbs. of seed (as against 34,960 last year) were sent to Dan Ja for distribution. The seed weight includes 4,300 lbs. from outside farmers' cotton, and an approximately similar amount was included in last year's figure also.

The Corporation's small press was not used last season as it was thought that the light pressing at Daudawa and the subsequent re-baling and full pressing at the Funtua Ginnery of the B.C.G.A. probably accounted last year for the poor appearance of the lint on its arrival in England. Bags capable of holding 150 to 200 lbs. of lint were accordingly made and the lint was trampled into them. They were then sent to Funtua for baling. The seed was, as usual, sent to Dan Ja in 100 lb. bags and, owing to difficulties with transport, the Corporation's own lorry and trailer conveyed it.

During the ginning period, picking was held up on several occasions owing to the inability of the gin to cope with the full amount of the daily picking, and the insufficiency of the storage accommodation. To remedy this a new Dobson & Barlow 40-saw gin is in course of erection and will be in use for the 1930–31 crop.

Waterworks.

A new water scheme has been installed since last year which has put the waterworks system on to an absolutely trouble-free footing. One of the hot-air pumping engines has been removed to near the residential site, and a boiler and steam pump have been put in its place, the remaining hot-air engine being left as an auxiliary. No structural alterations were necessary for the change-over at the pumping station. A 1,600 gallon steel tank on a 35 foot tower was erected at the site of the No. 2 storage tank and the water is now pumped direct into the former, whence it gravitates to small automatically controlled terminal tanks at the Co-operative site, ginnery and cattle sheds, besides supplying stand-pipes elsewhere. The ginnery tank is also automatically controlled and from it is fed the terminal tank in the labour lines. A stand-pipe has been placed on the farm, but for this extension, and for the Co-operative water scheme, more piping will be required. These extensions will be made gradually as time and conditions permit. Eventually it is hoped to give each group of four Co-operative houses a separate tank.

A small engine house has been built at the foot of the elevated tank for one of the hot-air engines, the function of which is to pump water from the main tank into the elevated tank : the surplus water from the latter runs into the tank beneath it after the various terminal tanks have been supplied. The steam pump in one day thus supplies all the terminal tanks and almost fills the No. 2 storage tank, providing enough water for four days' pumping with the hot-air engine. This obviates the necessity of working the big pump at the river every day. In order to reduce internal friction, 2 inch pipe has been substituted for 1 inch over part of the distributing system.

Buildings.

The masons were engaged for some time on the foundation works of the water tower. The holes required were 5 feet square at the top with a bigger area at the base. A considerable quantity of concrete was used in these and in addition a further cubic yard was placed on each foot of the legs of the tower after erection. The masons also constructed a small house with concrete floor at the base of the tower for the hot-air engine, used as an auxiliary pump. Several tanks fitted with ball-valve taps were built at the cattle sheds, labour lines, and Co-operative site.

A temporary native grain store with two compartments was built on the farm ; it is, however, insufficient for present needs, and another will be built.

The foundations for the six new Co-operative houses have been built by our masons, and the houses themselves, which are of mud, by native contractors. Another house of similar type was erected near the staff lines for the clerk.

A culvert and dam were built in one field to prevent the spread of erosion there and to bring about the silting-up of the holes already caused thereby. It seems likely that the scheme will be successful. Seven permanent culverts were also built in the farm roads to assist the top-water to get away quickly without overflowing and washing out neighbouring fields.

A new cattle-shed is in course of erection and should house 25 cattle comfortably. It is of the same type as before, but will have concrete lintels and should be as nearly as possible ant-proof.

A number of new round houses for labour have been built by native contractors.

Residential Site.

The garden at the residential site is progressing well, and besides the vegetables which are grown there during the rains, a great number of seedlings of various kinds are also propagated. Another line of Pride of Barbados was planted down the avenue, while a second of *Dalbergia Cesa* was planted behind the first and staggered.

Another mixed consignment of fruit and ornamental trees was purchased from Ibadan, but unfortunately many died in the dry spell in June. Groundnuts were planted in the orchard as a cover crop. These have now been harvested and a good crop was lifted. The drive, which has not had much attention since construction almost five years ago, has been re-metalled with laterite and three small culverts put in to take off the storm water. A number of ornamental trees and shrubs have been grown from seed given by the Forestry Department, some of these having been planted at the pump-house and other places, while numbers have been given to the Co-operative farmers and others.

A large number of banana suckers has also been given away among the work people.

Co-operative Farms.

The five farms cleared and cultivated in the season 1928–29 all had excellent crops of cereals and cotton. Houses were provided for these farms at an approximate cost of £7 each, including a laterite foundation to ground level. In addition, a house was built for the farm C.1 which, owing to the outcrops of rock in it, had not then been occupied. At the present time 12 farms are occupied fully.

During the past season water has been laid as far as farm B.2, and it is hoped to extend this line a further two blocks in the near future. The provision of a water supply is much appreciated.

All the farmers have had good crops. Average cotton yields varied from 145 to 426 lbs. of seed cotton per acre, but the land from which only 145 lbs. was obtained was in its first year of cultivation. On the older farms the lowest average yield was 270 lbs. per acre, which is high in comparison with the usual yields from native farms. All the cotton was of good quality, and the cleanliness in picking left nothing to be desired. In all, the estimated area under cotton was 31½ acres, producing a total of 7,655 lbs. of No. 1 seed cotton; an average of 243 lbs. per acre as against 214 lbs. last year. The yields of cereals were very good; nearly all of the farmers getting round about 1,000 lbs. per acre of both millet and guinea-corn.

The most interesting and important new feature to be recorded is the fact that the farmers are taking up cattle cultivation. This advance is directly due to their recognition of the value of cattle cultivation on the Main Farm. Four tenants are already engaged in paying for cattle by instalments: two farmers purchase one bullock each and share a plough; they are very anxious to get a D.Y. plough from England, but for the time being a plough is lent them at week-ends when it is not in use on the Main Farm. In most cases extensions are being made, and cattle cultivation will make it possible for a farmer to run not only his own farm of 10 acres, but an adjoining one also. One man has already reached his limit of 10 acres and a second has very little left uncultivated. These two will inaugurate the system of cattle cultivation on the Co-operative Farms.

For the first time also a start was made on the older farms with green manuring, although admittedly on a small scale. It is hoped that the practice will extend in ensuing seasons. The native does not view with favour what seems to him a waste of land when green manure is the only crop, so he is being encouraged to inter-plant the beans in his cereals and thus get the benefit without the apparent waste of time and labour. The necessity for manure of some kind is well understood, however, and the majority of the farmers had Fulani cattle kraaled on their land during the last dry season.

Another new idea in connection with the Co-operative Scheme is the donation of two or three small prizes annually for the best farmed farms and the neatest compounds. The Director of Agriculture, is the judge and views the farms during one of his visits to the Northern Provinces. On his suggestion a differentiation is made between the new farmers and those who have been established some time, separate prizes being offered.

Four new farms were cleared and cultivated last dry season, ready for planting in the rains. Half of each was planted in cotton and half in cereals. These four farms complete the first belt of Co-operative Farms across the Corporation's plot of land, and make 16 in all. Houses will later be built ready for occupation in the coming spring. The new farms suffered somewhat in the locust invasion, there being no one near to keep the locusts away. The damage was confined to the cereals, the cotton, in common with the other cotton on the farm, remaining untouched.

The farms are now a proved success, and no difficulty is experienced in selecting suitable farmers from those who offer themselves as tenants. Ex-soldiers are given preference if they have worked on the Main Farm for a year or two and have proved themselves completely satisfactory.

The Locust Invasion.

The first locusts seen in the neighbourhood of Daudawa appeared in the month of May, though they had previously been reported from the Zaria and Kaduna districts. The invasion came from the south and moved steadily northwards until the locusts arrived in the vicinity of Lake Chad where they stayed for some time. Towards the middle of September they began to return, the general drift being to the south and west, and when this report was written in October last, they were still passing in occasional large flights. The position was so serious when the cereal crops were growing that measures were taken to prevent food shortage in the country and Europeans volunteered their services to combat the menace. The Manager was appointed Anti-Locust Officer in the Kogo district, this being the district in which Daudawa is situated.

On the Corporation's farm, the position was definitely serious as regards cereals. Details are given above under the paragraphs dealing with those crops. Purchases were made locally to tide over until the new crops were gathered, and a ton of rice was obtained from the Agricultural Department's mill at Sokoto. Since then a further ton has been acquired for sale to the labourers. The locusts have not yet damaged either the cotton or beans directly, but it still remains to be seen what will happen when the bushfires destroy the grass.

All the accepted methods were employed in dealing with them, including digging trenches and driving the hoppers into them, beating them out on the ground when driven together, and poison bait. The last has proved the best method up to now, but a Flammenwurfer and crude oil have been issued for use if necessary.

The danger to the cereal crop of the country is now almost past, but some districts have suffered more than others and it is more than likely therefore that local shortages may occur, though, so far as can be seen at the moment, a shortage does not seem likely in the Daudawa neighbourhood as the natives with small farms are in a position to beat off the locusts.

Meteorological Notes.

Rain commenced on March 30th and continued until the end of October, rather later than usual, and it was then not at all certain that more would not fall. The rains usually end about October 20th, but last year a very welcome rain of 0·79 inch fell on the 31st, which did a lot of good. The distribution at the beginning of the rainy season was good, but became less satisfactory later on, August and September being the worst months, with heavy and very irregular rains.

Next season it is intended to try the effect of rearranging the ridges in many fields so that the storm water can get away, and thus prevent washing out. The year 1930 had the least rainfall in the aggregate of any since the farm began, the total being 43·28 inches as compared with 43·39 inches in 1928, which was formerly the least, and 55·77 inches in 1927, which was the highest since 1925, when the farm records commenced. It may be taken that about 45 inches is about the average.

Planting commenced on June 9th as stated previously, the rains then being good, but a dry spell in July held up operations somewhat.

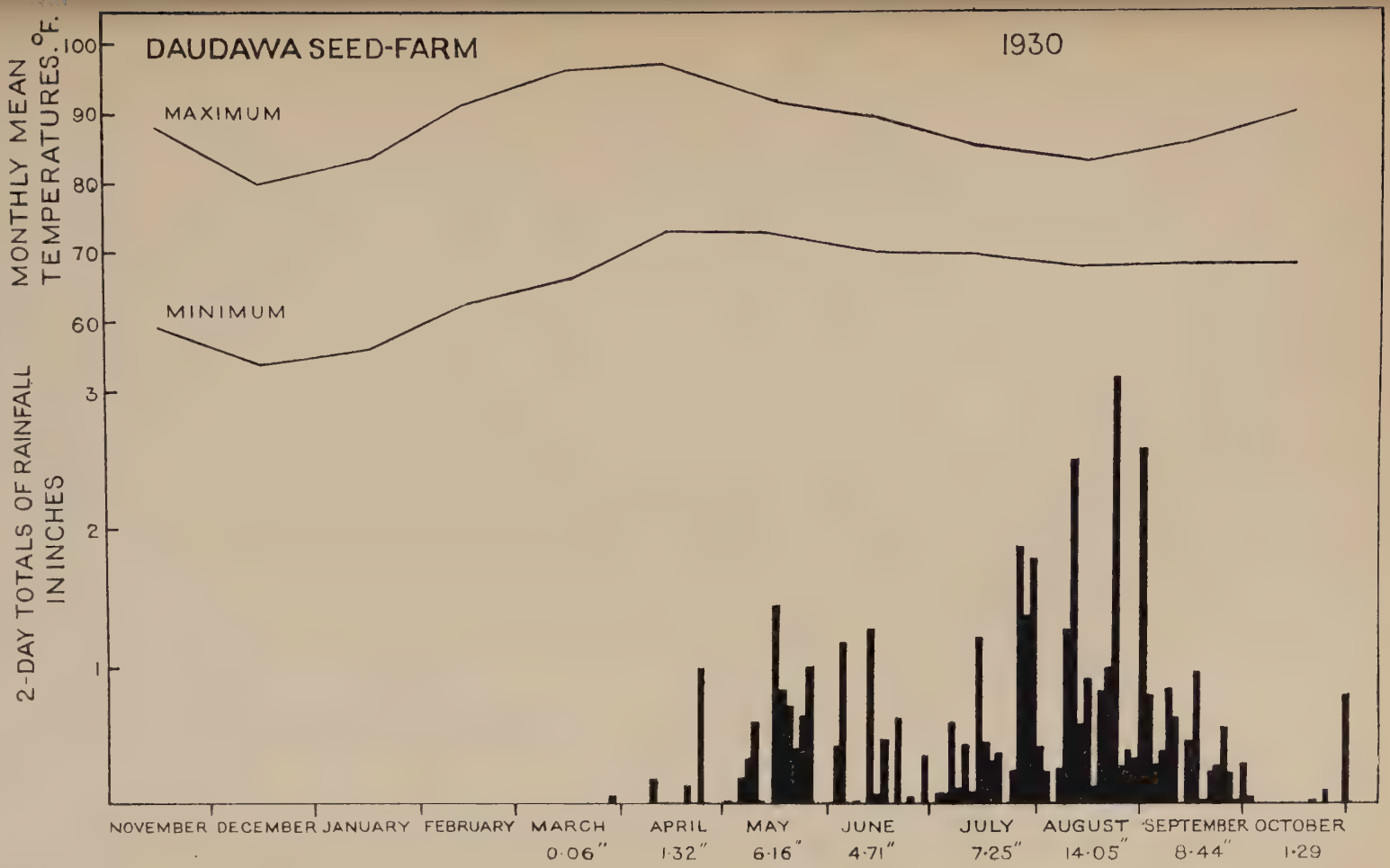
General.

The farm continues to attract large numbers of visitors who are always welcome. During October the Acting Lieut.-Governor of the Northern Provinces visited the farm, and expressed great interest in all he saw, especially in the Co-operative farms. The Director of Agriculture and members of his Staff visit Daudawa when in the neighbourhood.

Among other visitors have been the Director of Education, who was also specially interested in the Co-operative Scheme. The Emir of Katsina, who has given great assistance to the Corporation on many occasions, always visits the farm when in this part of his Emirate. He was particularly helpful during the locust campaign.

Cotton in the surrounding district, while not sown so extensively as last year, promises to produce good crops. A noticeable feature in the immediate vicinity of Daudawa is the way in which the native has improved his farming methods on the lines of those practised on the Seed Farm. This is naturally very gratifying and shows that the farm is fulfilling one of its secondary objects.

The health of the European and African Staff has, on the whole, been good with the exception of the usual minor ailments.


DAUDAWA SEED-FARM
1930
MONTHLY MEAN TEMPERATURES. °F.
100
90
80
70
60
MAXIMUM
MINIMUM
2-DAY TOTALS OF RAINFALL IN INCHES
3
2
1
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
0·06"
APRIL
1·32"
MAY
6·16"
JUNE
4·71"
JULY
7·25"
AUGUST
14·05"
SEPTEMBER
8·44"
OCTOBER
1·29

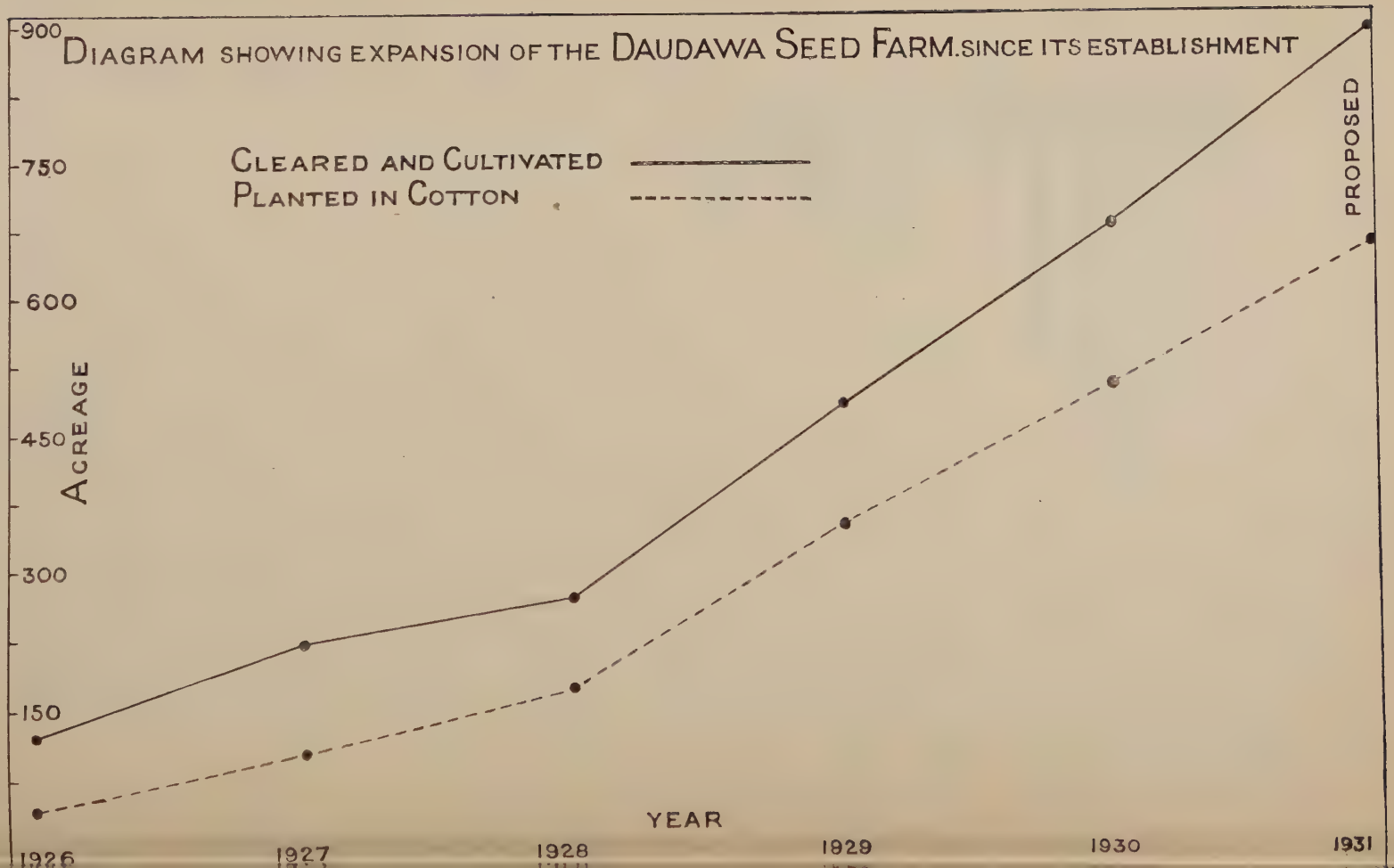
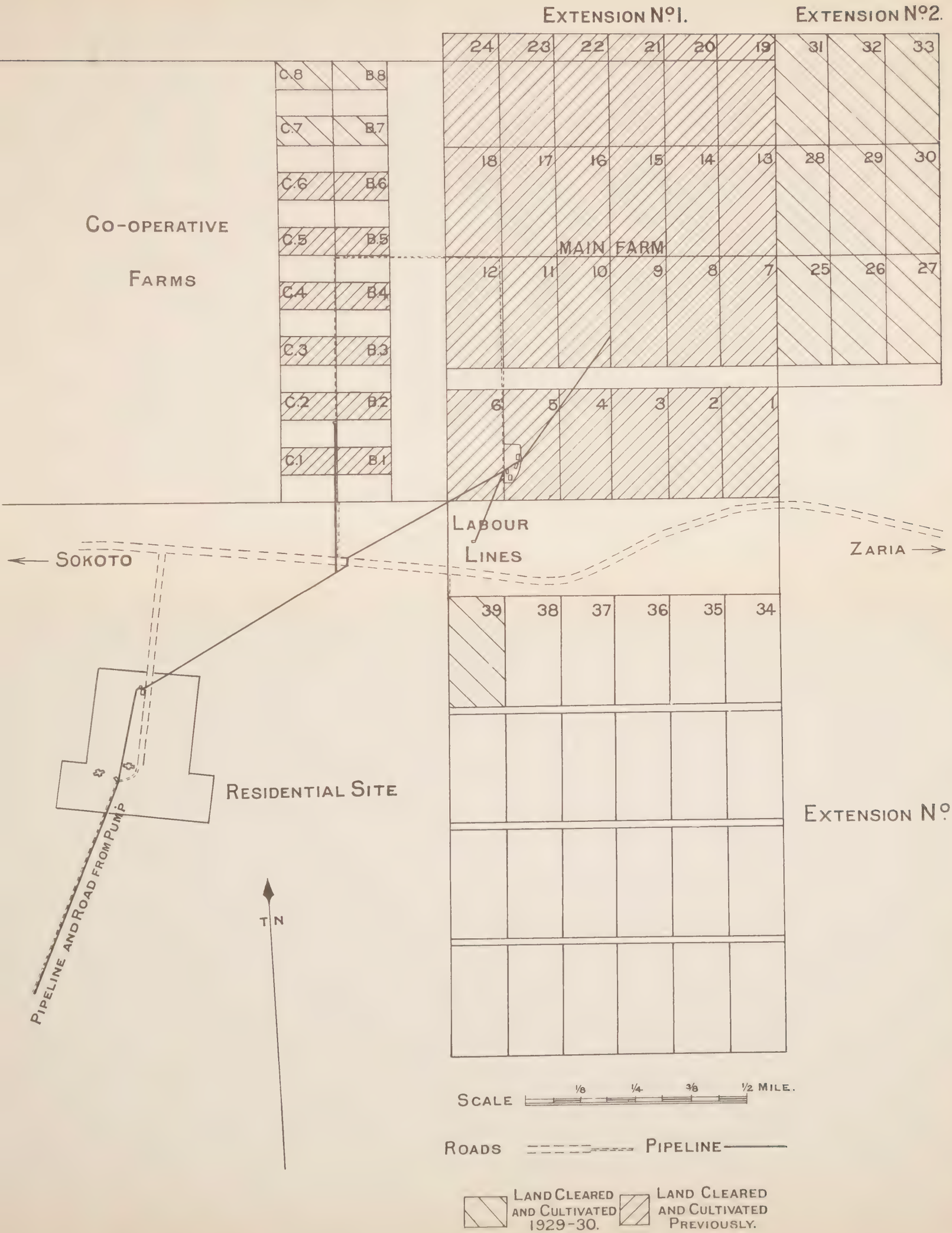


DIAGRAM SHOWING EXPANSION OF THE DAUDAWA SEED FARM. SINCE ITS ESTABLISHMENT
CLEARED AND CULTIVATED
PLANTED IN COTTON
900
750
600
450
300
150
ACREAGE
PROPOSED
YEAR
1926
1927
1928
1929
1930
1931

DAUDAWA SEED FARM. 1930.



FIJI

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, SIGATOKA, FOR THE SEASON 1929-30.

BY
R. R. ANSON.

The following interim report has necessarily been hurriedly prepared so that it may be in time for inclusion in the Corporation's annual publication. Picking is still in progress, however, and will continue for all the New Guinea hybrid types until the end of the year, on this account it is impossible to include the results of a number of experiments.

SUMMARY.

Despite a very bad beginning to the season, when heavy windstorms followed by floods necessitated a complete re-sowing of most of the fields, the past season has been the most favourable one for cotton-growing experienced since the Experiment Station was opened.

It has been decided to discontinue growing the New Guinea Kidney hybrid, which, although hardy and a most prolific yielder, has not been altogether satisfactory, and the lint has been as difficult to sell as was formerly Sea Island. During the coming season, Sea Island will be distributed to all districts.

Experiments made with a Kidney × Sea Island backcross show promise, and the yield obtained from it has been most remarkable. This has probably been caused by hybrid vigour enhanced by extremely favourable growing conditions. The average number of bolls which reached maturity on three of the best plants amounted to 641. The yield per acre (although admittedly calculated from 50 plants only) worked out at 3,732 lbs. of seed cotton for one strain, and 2,575 for another.

Some spacing experiments were made with New Guinea cotton, and preliminary results indicated that the closest spacing adopted gave the best yields.

Various rotation crops have been tried in view of the fact that those that have usually been included hitherto in the rotation, namely, maize and cowpeas, both have a very limited and purely local market.

Insect attack on the cotton has been very light during the past season.

Season.

During the second week in December, torrential rains aided by a strong gale which blew at hurricane force for nearly three days, banked up the river so that it rose to about 30 feet above its normal level in places and caused a general flood. Some of the lower areas had from four to five feet of water passing over them, and newly planted cotton crops were completely killed off either by wind or flood. This was most disastrous as it wiped out practically all progeny rows of single-plant selections. Fortunately many of the backcrosses were saved, as they happened to be on slightly higher ground. The blow was followed by exceptionally dry weather which set in towards the end of March and, with the exception of a few odd showers, the weather has remained dry with cold nights and bright sunny days right up to the time of writing (end of October). In the Western districts, where Sea Island cotton is being grown, the season has been, if anything, too dry, and in consequence there has been no top crop, but in this district which borders between the wet and the dry zones, it has been ideal for cotton.

Selections.

Sea Island. The seed from S17 strain has been distributed to all growers in the Lautoka area, and samples drawn from various districts at different dates show the following ginning percentages etc:

Date.	*District.*	*Wt. of 100 seeds. grms.*	*Lint index.*	*Ginning out-turn.*	*Average lint length. mm.*
23 : 7 : 30	Magere	13·06	3·92	24·5%	52
29 : 7 : 30	Lautoka	13·30	4·05	24%	53
5 : 8 : 30	Koro No. 1	11·24	3·84	26·8%	52
6 : 9 : 30	Dreketi	12·09	4·39	26·25%	51

The higher weight of the seed of the first two samples is due to a very heavy greenish tuft which has appeared suddenly and cannot be accounted for. In case the original selection may be splitting up, it will be advisable to make further selections in the coming season in order if possible to eliminate this undesirable factor.

Re-selections from Two Lines Grown at the Station.

No.	*Wt. of seed cotton per boll. gms.*	*Wt. of 100 seeds. gms.*	*Lint index.*	*Ginning %*	*Staple. mm.*	*Total seed cotton gms.*	*Calculated yield per acre. lbs.*
S17-4-2 ...	3·4	13·45	4·39	24·5	53	126	504
S17-4-5 ...	3·31	13·39	4·48	27·5	52	137	548
S17-4-6 ...	2·95	11·18	3·61	25	53	58	232
S17-4-9 ...	3·69	13·30	4·15	23·5	54	139·25	557
S17-4-12 ...	3·16	13·43	4·09	25	51	58	232
S17-4-16 ...	3·58	12·92	4·41	25·9	53	272	1,089

All plants were severely attacked by tipworm at squaring time and this largely accounts for the poor yield.

Backcrosses. The writer is indebted to Dr. S. C. Harland for several types of cotton brought from the Cotton Research Station Trinidad, and tried out in single lines at this Station, also for a set of grades for petal spot and other morphological characters of the plant which were kindly prepared by a member of his staff.

The most interesting of these cottons is a Trinidad Red Kidney backcrossed with a mutation from Sea Island and known as Crinkled Dwarf on account of its crinkly leaf and dwarfed habit of growth. Seed was sown in August 1929 but only 43 plants survived the hurricane. The genetic behaviour of these is being followed up on lines similar to those employed by Dr. Harland.

It is hoped to breed up types which possess the robust and disease resistant characteristics of the Kidney with a lint comparable in quality with that of Egyptian cottons.

New Guinea Hybrid × *Sea-Island.*—Five plants from K3-2 and two from K11 type were selected and crossed with Sea-Island (type S17-4). In each case the New Guinea Hybrid (which is suspected to have originated from a Sea-Island × Kidney cross) was used as the female parent. The product of this cross bears the robust habit of the Kidney type and the lint characters of Sea-Island, it averages seven feet in height and carries an unusually heavy crop of bolls. Seven hundred and thirty-two bolls were gathered from the best plant and the average number harvested from three good plants amounted to 641. A total number of 472 plants survived the flood and out of this number 273 have been selfed and records kept of various morphological characters for each plant. This should facilitate selection during the coming season of plants breeding true, and at the same time enable all heterogenous lines to be quickly distinguished and rogued. Two hundred and fifty progeny lines will be planted next season and carefully watched for regularity of habit.

Spacing Tests with New Guinea Cotton.

The space between plants in the row was five feet in every instance and four different spacings were tested between rows grouped in pairs ; an average of eleven rows was taken for each spacing and four tests were made of each group, the groups being distributed throughout the field at random. The standard for comparison was 7 feet by 5 feet ; by this is meant 5 feet between each row in a pair, and 7 feet between a row of one pair and the nearest row of the next pair.

Spacings.	*Yield S/c lbs. per acre.*	*Mean difference from standard.*
8′ × 6′	1,025	−119
7′ × 5′	1,144	—
10′ × 6′	639	−405
6′ 6″ × 4′ 6″	1,414	270

Probable error of mean = 42 lbs. per acre.

Close spacings gave the best results, but plants did not put on as vigorous vegetative growth as they would have done if the season had not been a particularly dry one. In a wetter season there would have been a fair amount of shedding caused by wet feet brought about by too much shade. At least 25% of this crop has yet to be picked.

Ratoon.

Increase plots of seven acres and four acres from last year's selections (K3-2 and K8-2) were ratooned to within 3 feet 6 inches of the ground level; the former type has yielded 7,250 lbs. of seed cotton; only about 60% of the cotton has as yet been picked from the latter type, which has so far yielded 1,467 lbs. or 366·75 lbs. to the acre. Annual cotton of the same strain has yielded 407 lbs. per acre but it is estimated that only 25% of the crop has yet reached maturity.

Insect Pests.

All cotton has been particularly free from pests this season. Jassid was fairly bad until the month of March, after which it completely disappeared.

Rotation Crops.

It has been decided to try out a number of crops both in rotation and in conjunction with cotton. The usual rotation practised has in the past been maize and cowpea, and yields up to 40 bushels per acre have been obtained for both. However, they both have a very limited market which is purely local and easily glutted.

Field Onion. (*Allium cepa*). A few lines were sown with Indian imported seed and a good stand was obtained. During the latter part of July about 50% of the crop was wiped out by the Cane Army Worm (*Cirphis unipuncta*) which was eventually controlled by hand picking, and the onions are now bulbing well and have a healthy appearance.

Wheat. (*Triticum vulgare*). Two plots each measuring ¼ acre were sown with wheat of a hard bearded type imported from India, one plot was broad cast and the other sown in drills ; neither plot has done remarkably well, but conditions have been against them. They were badly attacked by loopers (*Alabama argilacea* Hubn), and from the very beginning have suffered from particularly dry conditions. The broadcast plot has yielded 14·5 bushels per acre ; the other plot has yet to be harvested ; it was sown at the same time, but is much more backward.

A small plot of Mung has been sown for seed and will be tried out in rotation with rice, five acres of which is being planted for experimental purposes and also to supply farm labour with food.

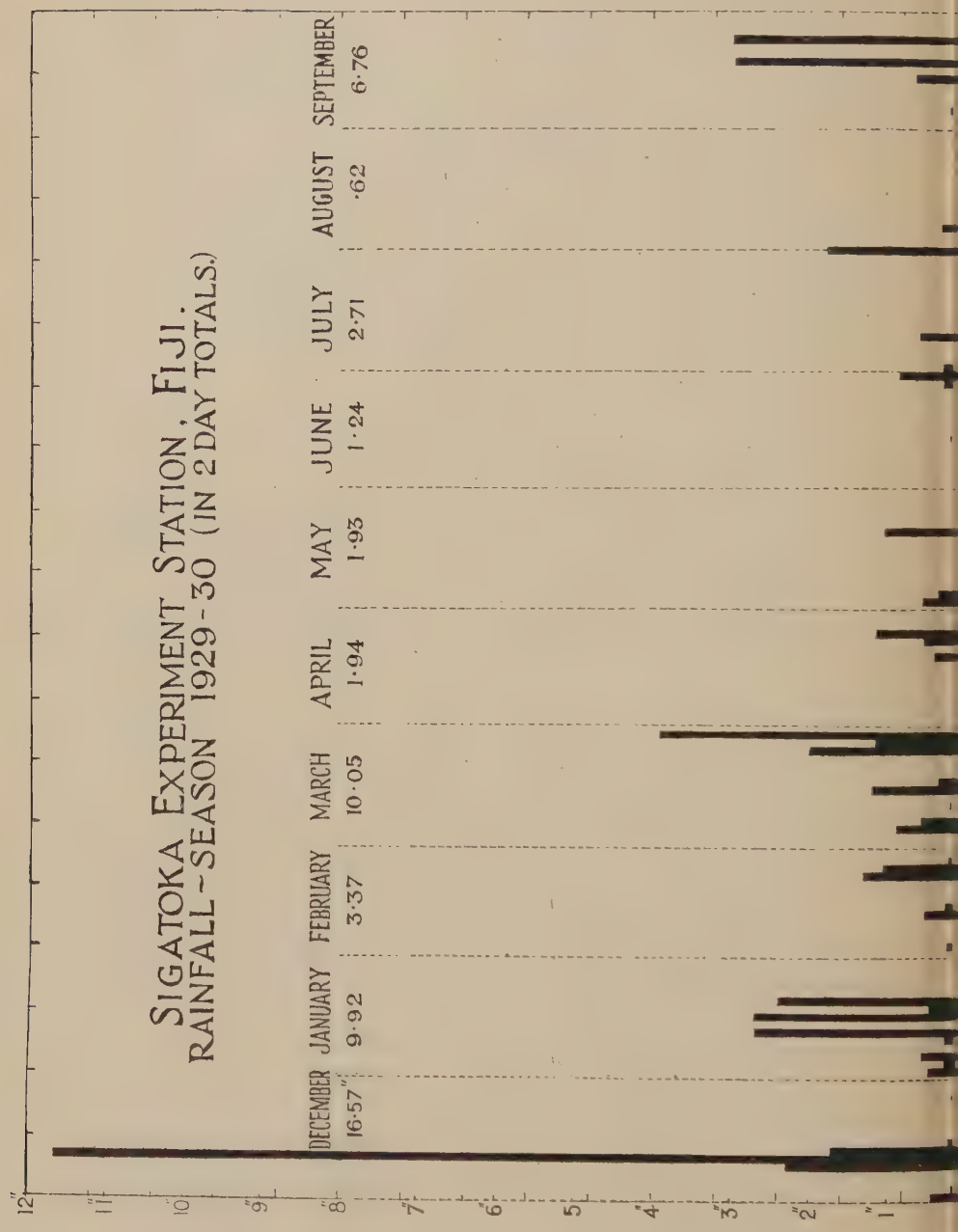
Oil Seeds.—A small nursery has been planted up with Tung oil (*Aleurites fordii* and *Aleurites montana*). The former variety is making vigorous growth and a germination of 80% was obtained. A number of seedlings have been set out on various types of soil. The latter variety has failed to germinate.

Marotti (*Hydnocarpus wightiana*) seed recently received from India has been planted in the nursery. It is said to possess properties similar to those of Chaulmoogra oil and yields a greater percentage.

Corander (*Corandrum sativa*). This crop was planted on a well manured seed bed. It germinated well and has made excellent growth, but a certain amount of difficulty is experienced in harvesting and drying out the crop.

Gliricidia maculata, a leguminous shrub, has germinated exceedingly well and will be set out around some of the fields as a hedge. It should make a good wind break and at the same time loppings ploughed in from it make an excellent green manure.

Six acres of moderately uniform soil have been set aside for crop rotation experiments and the seed is being multiplied up from small plots of Soya beans (three varieties), Mauritius beans, rice beans and cowpea. A series of manurial tests will be tried out with Sea Island cotton on another block.


SIGATOKA EXPERIMENT STATION, FIJI.
RAINFALL-SEASON 1929-30 (IN 2 DAY TOTALS.)
DECEMBER 16·57"
JANUARY 9·92
FEBRUARY 3·37
MARCH 10·05
APRIL 1·94
MAY 1·93
JUNE 1·24
JULY 2·71
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12"
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